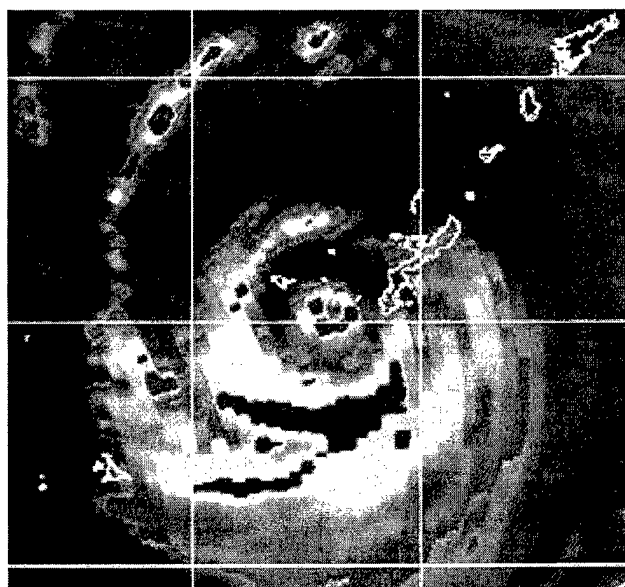


# **1999**

## **Annual Tropical Cyclone Report**

**U.S. Naval Pacific Meteorology and Oceanography Center/ Joint Typhoon Warning Center  
Pearl Harbor, Hawaii**



Tropical Rainfall Measuring Mission (TRMM) microwave imagery of Super Typhoon Bart (24W) as the system passed Okinawa. Imagery is from 0917Z on September 22, 1999. Maximum intensity of the system was estimated at 140 knots.

**Terry McPherson**

Captain, United States Navy  
Commanding Officer

**Wendell Stapler**

Lieutenant Colonel, United States Air Force  
Director, Joint Typhoon Warning Center

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# 1. SUMMARY OF NORTH WEST PACIFIC AND NORTHERN INDIAN OCEAN TROPICAL CYCLONES

## 1.1 NORTH WEST PACIFIC OCEAN TROPICAL CYCLONES

Tropical cyclone genesis regions compared to the 15-year average are shown in Figure 1-1. This year's tropical cyclones are listed in Table 1-1. Table 1-2 shows the monthly distribution of tropical cyclones for each year since 1959 and Table 1-3 shows the monthly average occurrence of tropical storms separated into: (1) typhoons only; and (2) tropical storms and typhoons. A summary of this year's Tropical Cyclone Formation Alerts is shown in Table 1-4. The annual number of tropical cyclones of tropical storm strength and higher appear in Figure 1-2, while the number of super typhoons are shown in Figure 1-3. Composites of the tropical cyclone best tracks for the North West Pacific appear in Figures 1-4a, 1-4b, 1-4c, 1-4d, and 1-4e.

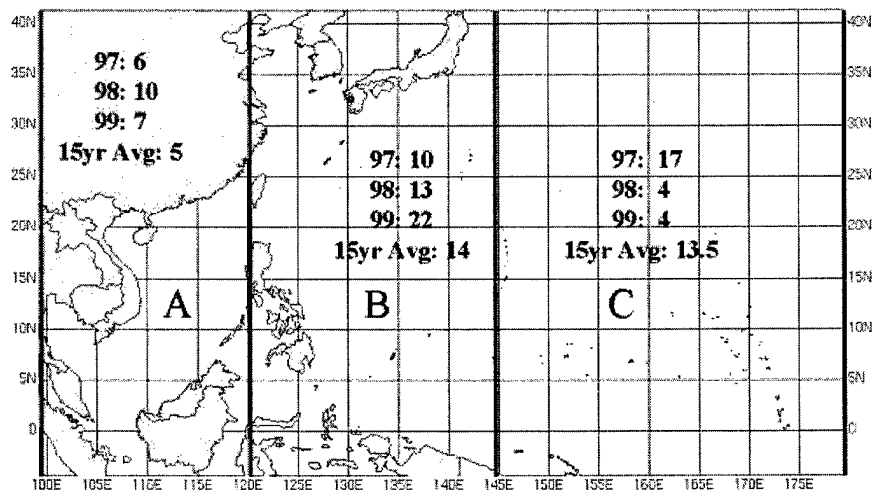


Figure 1-1. Comparison of the number of tropical cyclones that developed within 3 designated areas for 1997, 1998, 1999 and the 15-year average.



Table 1-1 WESTERN NORTH PACIFIC SIGNIFICANT TROPICAL CYCLONES FOR 1999 (01 JAN 1999 - 31 DEC 1999)

| TC             | NAME       | PERIOD        | NUMBER<br>ISSUED | EST<br>MAX SFC<br>WINDS<br>KTS<br>(M/SEC) | MSLP (MB) |
|----------------|------------|---------------|------------------|---|-----------|
| 01W            | TS HILDA   | 04 Jan 07 Jan | 12               | 35 (18)                                   | 997       |
| 02W            | TS IRIS    | 16 Feb 19 Feb | 13               | 35 (18)                                   | 997       |
| 03W            | TS JACOB   | 06 Apr 10 Apr | 16               | 35 (18)                                   | 997       |
| 04W            | TY KATE    | 22 Apr 28 Apr | 27               | 75 (39)                                   | 967       |
| 05W            | TY LEO     | 27 Apr 02 May | 24               | 110 (57)                                  | 933       |
| 06W            | TY MAGGIE  | 01 Jun 07 Jun | 24               | 105 (54)                                  | 938       |
| 07W            | -          | 15 Jul 18 Jul | 14               | 30 (15)                                   | 1000      |
| 08W            | -          | 21 Jul 22 Jul | 6                | 30 (15)                                   | 1000      |
| 09W            | TS NEIL    | 25 Jul 28 Jul | 13               | 40 (21)                                   | 994       |
| 10W            | -          | 28 Jul 27 Jul | 3                | 25 (13)                                   | 1002      |
| 11W            | TY OLGA    | 29 Aug 03 Aug | 24               | 80 (41)                                   | 963       |
| 12W            | TS PAUL    | 03 Aug 08 Aug | 19               | 50 (26)                                   | 987       |
| 13W            | TS RACHEL  | 06 Aug 09 Aug | 14               | 35 (18)                                   | 997       |
| 14W            | -          | 08 Aug 10 Aug | 8                | 30 (15)                                   | 1000      |
| *07E           | TY DORA    | 05 Aug 23 Aug | (56)14           | 120 (62)                                  | 922       |
| 15W            | -          | 16 Aug 18 Aug | 9                | 25 (13)                                   | 1002      |
| 16W            | TY SAM     | 18 Aug 23 Aug | 20               | 75 (39)                                   | 967       |
| 17W            | TY TANYA   | 19 Aug 24 Aug | 18               | 70 (36)                                   | 972       |
| 18W            | -          | 21 Aug 24 Aug | 10               | 30 (15)                                   | 1000      |
| 19W            | TY VIRGIL  | 24 Aug 29 Aug | 21               | 70 (36)                                   | 972       |
| 20W            | TS WENDY   | 01 Sep 04 Sep | 13               | 40 (21)                                   | 994       |
| 21W            | TY YORK    | 11 Sep 17 Sep | 22               | 70 (36)                                   | 972       |
| 22W            | TS ZIA     | 13 Sep 15 Sep | 7                | 35 (18)                                   | 997       |
| 23W            | TS ANN     | 15 Sep 20 Sep | 18               | 45 (23)                                   | 991       |
| 24W            | STY BART   | 17 Sep 24 Sep | 29               | 140 (72)                                  | 898       |
| 25W            | TS CAM     | 23 Sep 25 Sep | 11               | 45 (23)                                   | 991       |
| 26W            | TY DAN     | 02 Oct 11 Oct | 35               | 110 (57)                                  | 933       |
| 27W            | TS EVE     | 15 Oct 19 Oct | 18               | 35 (18)                                   | 997       |
| 28W            | -          | 05 Nov 06 NOV | 4                | 30 (15)                                   | 1000      |
| 29W            | TS FRANKIE | 06 Nov 10 NOV | 16               | 35 (18)                                   | 997       |
| 30W            | TY GLORIA  | 13 Nov 16 NOV | 13               | 65 (33)                                   | 976       |
| 31W            | -          | 01 Dec 04 Dec | 13               | 30 (15)                                   | 1000      |
| 32W            | -          | 09 Dec 11 Dec | 6                | 30 (15)                                   | 1000      |
| 33W            | -          | 14 Dec 16 Dec | 7                | 30 (15)                                   | 1000      |
| JTWC TOTAL     |            |               | 521              |   |           |
| ( )NPMOC TOTAL |            |               | 56               |   |           |
| GRAND TOTAL    |            |               | 577              |   |           |

\*WARNINGS ISSUED BY NPMOC

Table 1-2 DISTRIBUTION OF WESTERN NORTH PACIFIC TROPICAL CYCLONES FOR 1959 - 1999

| YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | TOTALS |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------|
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------|

Table 1-2 DISTRIBUTION OF WESTERN NORTH PACIFIC TROPICAL CYCLONES FOR 1959 - 1999

|      |     |     |     |     |     |     |     |     |     |     |     |     |          |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|
| 1959 | 0   | 1   | 1   | 1   | 0   | 1   | 3   | 8   | 9   | 3   | 2   | 2   | 31       |
|      | 000 | 010 | 010 | 100 | 000 | 001 | 111 | 512 | 423 | 210 | 200 | 200 | 17 7 7   |
| 1960 | 1   | 0   | 1   | 1   | 1   | 3   | 3   | 9   | 5   | 4   | 1   | 1   | 30       |
|      | 001 | 000 | 001 | 100 | 010 | 210 | 210 | 810 | 41  | 400 | 100 | 100 | 19 8 3   |
| 1961 | 1   | 1   | 1   | 1   | 4   | 6   | 5   | 7   | 6   | 7   | 2   | 1   | 42       |
|      | 010 | 010 | 100 | 010 | 211 | 114 | 320 | 313 | 510 | 322 | 101 | 100 | 20 11 11 |
| 1962 | 0   | 1   | 0   | 1   | 3   | 0   | 8   | 8   | 7   | 5   | 4   | 2   | 39       |
|      | 000 | 010 | 000 | 100 | 201 | 000 | 512 | 701 | 313 | 311 | 301 | 020 | 24 6 9   |
| 1963 | 0   | 0   | 1   | 1   | 0   | 4   | 5   | 4   | 4   | 6   | 0   | 3   | 28       |
|      | 000 | 000 | 001 | 100 | 000 | 310 | 311 | 301 | 220 | 510 | 000 | 210 | 19 6 3   |
| 1964 | 0   | 0   | 0   | 0   | 3   | 2   | 8   | 8   | 8   | 7   | 6   | 2   | 44       |
|      | 000 | 000 | 000 | 000 | 201 | 200 | 611 | 350 | 521 | 331 | 420 | 101 | 26 13 5  |
| 1965 | 2   | 2   | 1   | 1   | 2   | 4   | 6   | 7   | 9   | 3   | 2   | 1   | 40       |
|      | 110 | 020 | 010 | 100 | 101 | 310 | 411 | 322 | 531 | 201 | 110 | 010 | 21 13 6  |
| 1966 | 0   | 0   | 0   | 1   | 2   | 1   | 4   | 9   | 10  | 4   | 5   | 2   | 38       |
|      | 000 | 000 | 000 | 100 | 200 | 100 | 310 | 531 | 532 | 112 | 122 | 101 | 20 10 8  |
| 1967 | 1   | 0   | 2   | 1   | 1   | 1   | 8   | 10  | 8   | 4   | 4   | 1   | 41       |
|      | 010 | 000 | 110 | 100 | 010 | 100 | 332 | 343 | 530 | 211 | 400 | 010 | 20 15 6  |
| 1968 | 0   | 1   | 0   | 1   | 0   | 4   | 3   | 8   | 4   | 6   | 4   | 0   | 31       |
|      | 000 | 001 | 000 | 100 | 000 | 202 | 120 | 341 | 400 | 510 | 400 | 000 | 20 7 4   |
| 1969 | 1   | 0   | 1   | 1   | 0   | 0   | 3   | 3   | 6   | 5   | 2   | 1   | 23       |
|      | 100 | 000 | 010 | 100 | 000 | 000 | 210 | 210 | 204 | 410 | 110 | 010 | 13 6 4   |
| 1970 | 0   | 1   | 0   | 0   | 0   | 2   | 3   | 7   | 4   | 6   | 4   | 0   | 27       |
|      | 000 | 100 | 000 | 000 | 000 | 110 | 021 | 421 | 220 | 321 | 130 | 000 | 12 12 3  |
| 1971 | 1   | 0   | 1   | 2   | 5   | 2   | 8   | 5   | 7   | 4   | 2   | 0   | 37       |
|      | 010 | 000 | 010 | 200 | 230 | 200 | 620 | 311 | 511 | 310 | 110 | 000 | 24 11 2  |
| 1972 | 1   | 0   | 1   | 0   | 0   | 4   | 5   | 5   | 6   | 5   | 2   | 3   | 32       |
|      | 100 | 000 | 001 | 000 | 000 | 220 | 410 | 320 | 411 | 410 | 200 | 210 | 22 8 2   |
| 1973 | 0   | 0   | 0   | 0   | 0   | 0   | 7   | 6   | 3   | 4   | 3   | 0   | 23       |
|      | 000 | 000 | 000 | 000 | 000 | 000 | 430 | 231 | 201 | 400 | 030 | 000 | 12 9 2   |
| 1974 | 1   | 0   | 1   | 1   | 1   | 4   | 5   | 7   | 5   | 4   | 4   | 2   | 35       |
|      | 010 | 000 | 010 | 010 | 100 | 121 | 230 | 232 | 320 | 400 | 220 | 020 | 15 17 3  |
| 1975 | 1   | 0   | 0   | 1   | 0   | 0   | 1   | 6   | 5   | 6   | 3   | 2   | 25       |
|      | 100 | 000 | 000 | 001 | 000 | 000 | 010 | 411 | 410 | 321 | 210 | 002 | 14 6 5   |
| 1976 | 1   | 1   | 0   | 2   | 2   | 2   | 4   | 4   | 5   | 0   | 2   | 2   | 25       |
|      | 100 | 010 | 000 | 110 | 200 | 200 | 220 | 130 | 410 | 000 | 110 | 020 | 14 11 0  |
| 1977 | 0   | 0   | 1   | 0   | 1   | 1   | 4   | 2   | 5   | 4   | 2   | 1   | 21       |
|      | 000 | 000 | 010 | 000 | 001 | 010 | 301 | 020 | 230 | 310 | 200 | 100 | 11 8 2   |
| 1978 | 1   | 0   | 0   | 1   | 0   | 3   | 4   | 8   | 4   | 7   | 4   | 0   | 32       |
|      | 010 | 000 | 000 | 100 | 000 | 030 | 310 | 341 | 310 | 412 | 121 | 000 | 15 13 4  |
| 1979 | 1   | 0   | 1   | 1   | 2   | 0   | 5   | 4   | 6   | 3   | 2   | 3   | 28       |
|      | 100 | 000 | 100 | 100 | 011 | 000 | 221 | 202 | 330 | 210 | 110 | 111 | 14 9 5   |
| 1980 | 0   | 0   | 1   | 1   | 4   | 1   | 5   | 3   | 7   | 4   | 1   | 1   | 28       |
|      | 000 | 000 | 001 | 010 | 220 | 010 | 311 | 201 | 511 | 220 | 100 | 010 | 15 9 4   |
| 1981 | 0   | 0   | 1   | 1   | 1   | 2   | 5   | 8   | 4   | 2   | 3   | 2   | 29       |
|      | 000 | 000 | 100 | 010 | 010 | 200 | 230 | 251 | 400 | 110 | 210 | 200 | 16 12 1  |
| 1982 | 0   | 0   | 3   | 0   | 1   | 3   | 4   | 5   | 6   | 4   | 1   | 1   | 28       |

Table 1-2 DISTRIBUTION OF WESTERN NORTH PACIFIC TROPICAL CYCLONES FOR 1959 - 1999

|             | 000 | 000 | 210 | 000 | 100 | 120 | 220 | 500 | 321 | 301 | 100 | 100 | 19 7 2   |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----------|
| 1983        | 0   | 0   | 0   | 0   | 0   | 1   | 3   | 6   | 3   | 5   | 5   | 2   | 25       |
|             | 000 | 000 | 000 | 000 | 000 | 010 | 300 | 231 | 111 | 320 | 320 | 020 | 12 11 2  |
| 1984        | 0   | 0   | 0   | 0   | 0   | 2   | 5   | 7   | 4   | 8   | 3   | 1   | 30       |
|             | 000 | 000 | 000 | 000 | 000 | 020 | 410 | 232 | 130 | 521 | 300 | 100 | 16 11 3  |
| 1985        | 2   | 0   | 0   | 0   | 1   | 3   | 1   | 7   | 5   | 5   | 1   | 2   | 27       |
|             | 020 | 000 | 000 | 000 | 100 | 201 | 100 | 520 | 320 | 410 | 010 | 110 | 17 9 1   |
| 1986        | 0   | 1   | 0   | 1   | 2   | 2   | 2   | 5   | 2   | 5   | 4   | 3   | 27       |
|             | 000 | 100 | 000 | 100 | 110 | 110 | 200 | 410 | 200 | 320 | 220 | 210 | 19 8 0   |
| 1987        | 1   | 0   | 0   | 1   | 0   | 2   | 4   | 4   | 7   | 2   | 3   | 1   | 25       |
|             | 100 | 000 | 000 | 010 | 000 | 110 | 400 | 310 | 511 | 200 | 120 | 100 | 18 6 1   |
| 1988        | 1   | 0   | 0   | 0   | 1   | 3   | 2   | 5   | 8   | 4   | 2   | 1   | 27       |
|             | 100 | 000 | 000 | 000 | 100 | 111 | 110 | 230 | 260 | 400 | 200 | 010 | 14 12 1  |
| 1989        | 1   | 0   | 0   | 1   | 2   | 2   | 6   | 8   | 4   | 6   | 3   | 2   | 35       |
|             | 010 | 000 | 000 | 100 | 200 | 110 | 231 | 332 | 220 | 600 | 300 | 101 | 21 10 4  |
| 1990        | 1   | 0   | 0   | 1   | 2   | 4   | 4   | 5   | 5   | 5   | 4   | 1   | 31       |
|             | 100 | 000 | 000 | 010 | 110 | 211 | 220 | 500 | 410 | 230 | 310 | 100 | 21 9 1   |
| 1991        | 0   | 0   | 2   | 1   | 1   | 1   | 4   | 8   | 6   | 3   | 6   | 0   | 32       |
|             | 000 | 000 | 110 | 010 | 100 | 100 | 400 | 332 | 420 | 300 | 330 | 000 | 20 10 2  |
| 1992        | 1   | 1   | 0   | 0   | 0   | 3   | 4   | 8   | 5   | 6   | 5   | 0   | 33       |
|             | 100 | 010 | 000 | 000 | 000 | 210 | 220 | 440 | 410 | 510 | 311 | 000 | 21 11 1  |
| 1993        | 0   | 0   | 2   | 2   | 1   | 2   | 5   | 8   | 5   | 6   | 4   | 3   | 38       |
|             | 000 | 000 | 011 | 002 | 010 | 101 | 320 | 611 | 410 | 321 | 112 | 300 | 21 9 8   |
| 1994        | 1   | 0   | 1   | 0   | 2   | 2   | 9   | 9   | 8   | 7   | 0   | 2   | 41       |
|             | 001 | 000 | 100 | 000 | 101 | 020 | 342 | 630 | 440 | 511 | 000 | 110 | 21 15 5  |
| 1995        | 1   | 0   | 0   | 0   | 1   | 2   | 3   | 7   | 7   | 8   | 2   | 3   | 34       |
|             | 001 | 000 | 000 | 000 | 010 | 020 | 210 | 421 | 412 | 512 | 020 | 012 | 15 11 8  |
| 1996        | 0   | 1   | 0   | 2   | 2   | 0   | 7   | 10  | 7   | 5   | 6   | 3   | 43       |
|             | 000 | 001 | 000 | 011 | 110 | 000 | 610 | 433 | 610 | 212 | 132 | 111 | 21 12 10 |
| 1997        | 1   | 0   | 0   | 2   | 3   | 3   | 4   | 8   | 4   | 6   | 1   | 1   | 33       |
|             | 010 | 000 | 000 | 110 | 120 | 300 | 310 | 611 | 310 | 411 | 100 | 100 | 23 8 2   |
| 1998        | 0   | 0   | 0   | 0   | 0   | 0   | 3   | 3   | 8   | 6   | 3   | 4   | 27       |
|             | 000 | 000 | 000 | 000 | 000 | 000 | 012 | 210 | 413 | 213 | 030 | 112 | 9 9 9    |
| 1999        | 1   | 1   | 0   | 3   | 0   | 1   | 5   | 9   | 6   | 2   | 3   | 3   | 34       |
|             | 010 | 010 | 000 | 210 | 000 | 100 | 113 | 423 | 240 | 110 | 111 | 003 | 12 12 8  |
| (1959-1999) |     |     |     |     |     |     |     |     |     |     |     |     |          |
| MEAN        | 0.6 | 0.3 | 0.6 | 0.8 | 1.2 | 2.0 | 4.5 | 6.3 | 5.7 | 4.6 | 2.9 | 1.5 | 30.9     |
| CASES       | 23  | 14  | 23  | 31  | 48  | 80  | 183 | 260 | 233 | 190 | 119 | 63  | 1267     |

The criteria used in TABLE 1-2 are as follows:

- 1) If a tropical cyclone was first warned on the last two days of a particular month and continued into the next month for longer than two days, then that system was attributed to the second month.
- 2) If a tropical cyclone was warned on prior to the last two days of a month, it was attributed to the first month, regardless of how long the system lasted.
- 3) If a tropical cyclone began on the last day of the month and ended on the first day of the next month, that system was attributed to the first month. However, if a tropical cyclone began on the last day of the month and continued into the next month for only two days, then it was attributed to the second month.

TABLE 1-3 NORTH WEST PACIFIC TROPICAL CYCLONES

TYPHOONS (1945-1959)

TABLE 1-3 NORTH WEST PACIFIC TROPICAL CYCLONES

|       | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | TOTALS |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------|
| MEAN  | 0.3 | 0.1 | 0.3 | 0.4 | 0.7 | 1   | 2.9 | 3.1 | 3.3 | 2.4 | 2   | 0.9 | 16.4   |
| CASES | 5   | 1   | 4   | 6   | 10  | 15  | 29  | 46  | 49  | 36  | 30  | 14  | 245    |

## TYPHOONS (1960-1999)

|       | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | TOTALS |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------|
| MEAN  | 0.3 | 0.1 | 0.2 | 0.5 | 0.7 | 1.1 | 2.7 | 3.5 | 3.4 | 3.2 | 1.6 | 0.7 | 17.7   |
| CASES | 10  | 2   | 8   | 18  | 27  | 42  | 108 | 138 | 135 | 127 | 64  | 27  | 706    |

## TROPICAL STORMS AND TYPHOONS (1945-1959)

|       | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | TOTALS |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------|
| MEAN  | 0.4 | 0.1 | 0.5 | 0.5 | 0.8 | 1.6 | 2.9 | 4   | 4.2 | 3.3 | 2.7 | 1.2 | 22.2   |
| CASES | 6   | 2   | 7   | 8   | 11  | 22  | 44  | 60  | 64  | 49  | 41  | 18  | 332    |

## TROPICAL STORMS AND TYPHOONS (1960-1999)

|       | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | TOTALS |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------|
| MEAN  | 0.5 | 0.2 | 0.4 | 0.7 | 1.2 | 1.8 | 4.3 | 5.7 | 5.2 | 4.4 | 2.7 | 1.3 | 27.7   |
| CASES | 21  | 10  | 17  | 28  | 44  | 71  | 167 | 224 | 204 | 168 | 106 | 49  | 1109   |

TABLE 1-4 TROPICAL CYCLONE FORMATION ALERTS FOR THE NORTH WEST PACIFIC OCEAN FOR 1976-1999

| YEAR | INITIAL<br>TCFAS | TROPICAL<br>CY-<br>CLONES<br>WITH<br>TCFAS | TOTAL<br>TROP-<br>ICAL<br>CY-<br>CLONES | PROBABILITY<br>OF<br>TCFA<br>WITH-<br>OUT<br>WARN-<br>ING* | PROBABILITY<br>OF<br>TCFA<br>BEFORE<br>WARN-<br>ING |
|------|------------------|--|---|--|---|
| 1976 | 34               | 25   | 25                                      | 26%  | 100%  |
| 1977 | 26               | 20   | 21                                      | 23%  | 95%   |
| 1978 | 32               | 27   | 32                                      | 16%  | 84%   |
| 1979 | 27               | 23   | 28                                      | 15%  | 82%   |
| 1980 | 37               | 28   | 28                                      | 24%  | 100%  |
| 1981 | 29               | 28   | 29                                      | 3%   | 96%   |
| 1982 | 36               | 26   | 28                                      | 28%  | 93%   |
| 1983 | 31               | 25   | 25                                      | 19%  | 100%  |
| 1984 | 37               | 30   | 30                                      | 19%  | 100%  |
| 1985 | 39               | 26   | 27                                      | 33%  | 96%   |
| 1986 | 38               | 27   | 27                                      | 29%  | 100%  |
| 1987 | 31               | 24   | 25                                      | 23%  | 96%   |
| 1988 | 33               | 26   | 27                                      | 21%  | 96%   |
| 1989 | 51               | 32   | 35                                      | 37%  | 91%   |
| 1990 | 33               | 30   | 31                                      | 9%   | 97%   |
| 1991 | 37               | 29   | 31                                      | 22%  | 94%   |
| 1992 | 36               | 32   | 32                                      | 20%  | 100%  |
| 1993 | 50               | 35   | 38                                      | 30%  | 92%   |
| 1994 | 50               | 40   | 40                                      | 20%  | 100%  |
| 1995 | 54               | 33   | 35                                      | 39%  | 94%   |
| 1996 | 41               | 39   | 43                                      | 5%   | 91%   |
| 1997 | 36               | 30   | 33                                      | 17%  | 91%   |

TABLE 1-4 TROPICAL CYCLONE FORMATION ALERTS FOR THE NORTH WEST PACIFIC OCEAN FOR 1976-1999

|             |     |     |     |     |     |
|-------------|-----|-----|-----|-----|-----|
| 1998        | 38  | 18  | 27  | 53% | 67% |
| 1999        | 39  | 29  | 33  | 26% | 88% |
| (1976-1999) |     |     |     |     |     |
| MEAN:       | 37  | 26  | 30  | 30% | 87% |
| TOTALS:     | 893 | 682 | 730 |     |     |

\* Percentage of initial TCFA's not followed by warnings.

## 1.2 NORTH INDIAN OCEAN TROPICAL CYCLONES

This year's North Indian Ocean tropical cyclones are listed in Table 1-5. The monthly distribution of tropical cyclones for each year since 1975 is shown in Table 1-6. Composites of the tropical cyclone best tracks for the Northern Indian Ocean appear in Figure 1-5.

Table 1-5 NORTH INDIAN OCEAN SIGNIFICANT TROPICAL CYCLONES FOR 1999 (01 JAN 1999 - 31 DEC 1999)

| TC  | NAME | PERIOD                   | NUMBER<br>ISSUED | EST<br>MAX<br>SFC<br>WINDS<br>KTS<br>(M/SEC) | MSLP<br>(MB) |
|-----|------|--------------------------|------------------|--|--------------|
| 01B | -    | 02<br>Feb<br>- 04<br>Feb | 6                | 40 (21)                                      | 994          |
| 02A | -    | 16<br>May<br>- 21<br>May | 21               | 110 (57)                                     | 933          |
| 03B | -    | 10<br>Jun<br>- 11<br>Jun | 2                | 35 (18)                                      | 997          |
| 04B | -    | 15<br>Oct<br>- 18<br>Oct | 7                | 120 (62)                                     | 922          |
| 05B | -    | 26<br>Oct<br>- 01<br>Nov | 13               | 140 (72)                                     | 898          |

\*WARNINGS ISSUED BY NPMOC

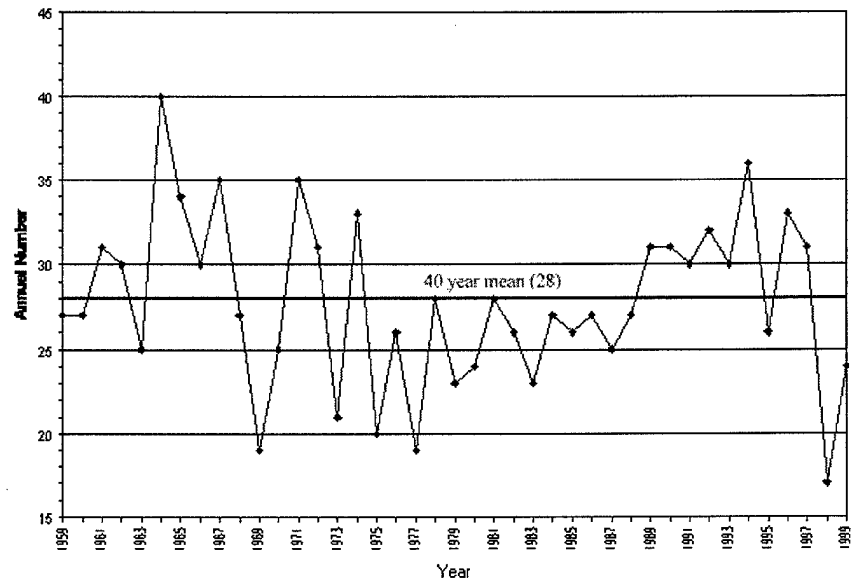


Figure 1-2. Tropical Cyclones of Tropical Storm or greater intensity in the North West Pacific (1959-1999).

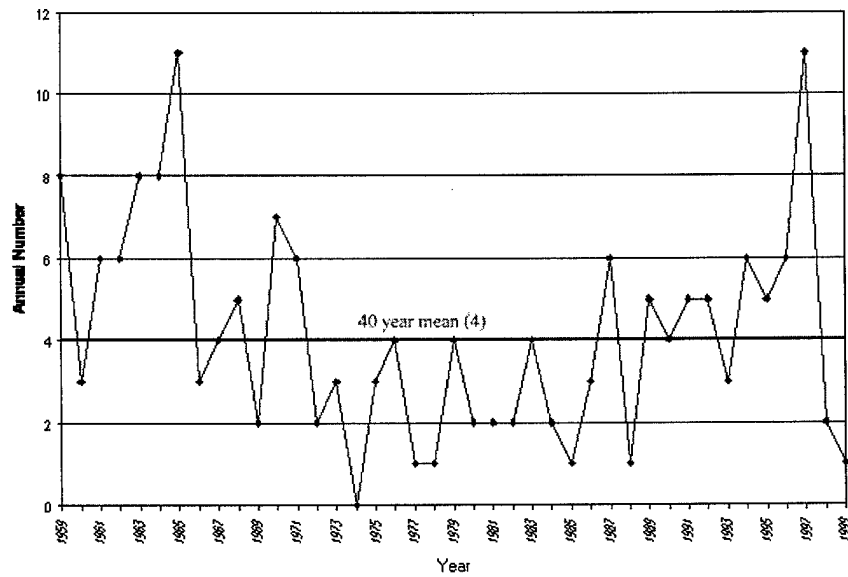
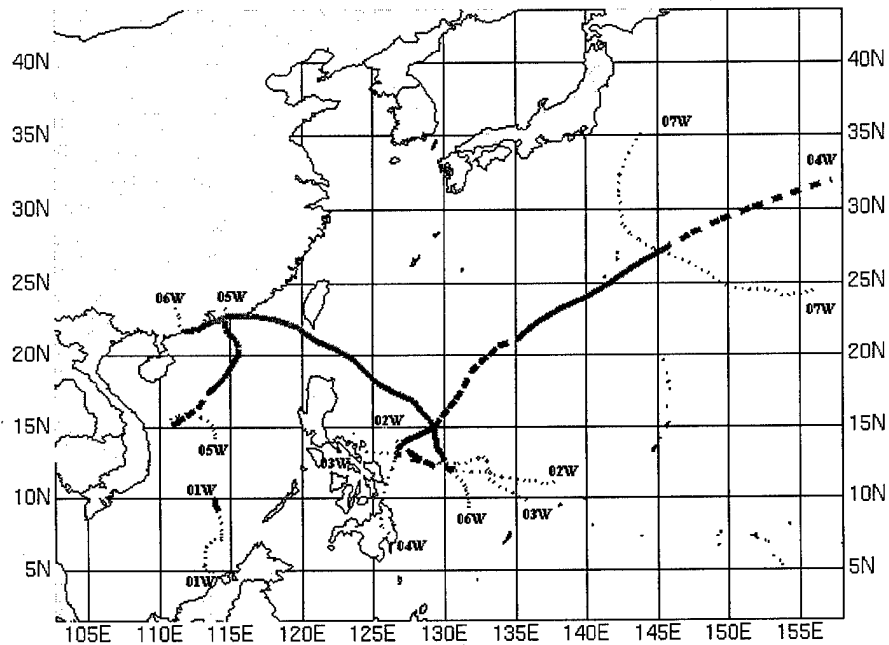


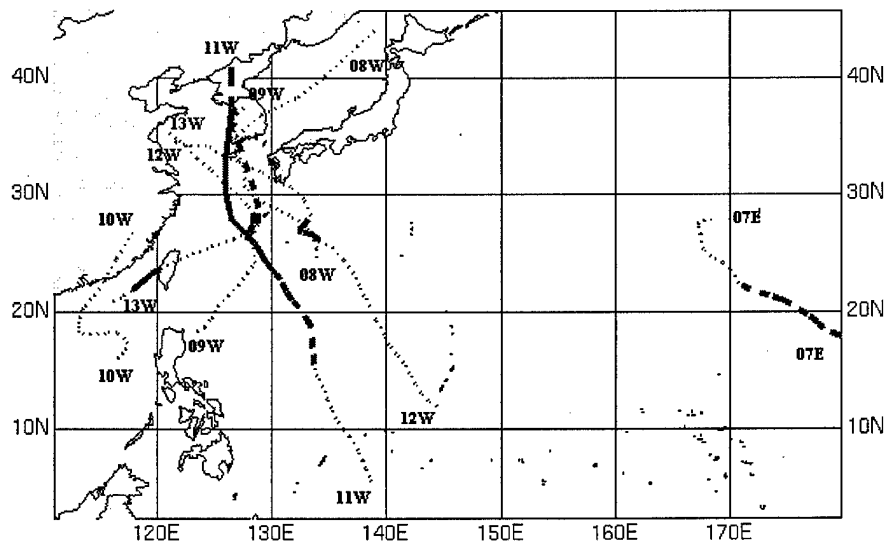
Figure 1-3. Number of North West Pacific Super Typhoons (1959-1999).



NORTHWEST PACIFIC OCEAN  
TROPICAL CYCLONES  
04 JAN 99 - 18 JUL 99

MAXIMUM SUSTAINED SURFACE WIND  
 ——— 64KT (33M/SEC) OR GREATER  
 - - - 34 TO 63KT (18 TO 32M/SEC)  
 ..... 33KT (17M/SEC) OR LESS

|               |                 |
|---------------|-----------------|
| 01W TS HILDA  | 04 JAN - 07 JAN |
| 02W TS IRIS   | 16 FEB - 19 FEB |
| 03W TS JACOB  | 06 APR - 10 APR |
| 04W TY KATE   | 22 APR - 28 APR |
| 05W TY LEO    | 27 APR - 02 MAY |
| 06W TY MAGGIE | 01 JUN - 07 JUN |
| 07W TD        | 15 JUL - 18 JUL |

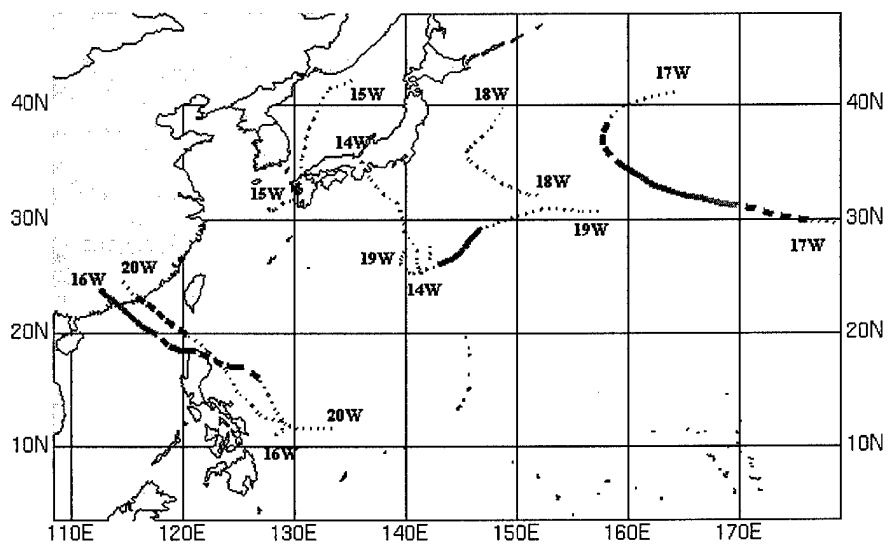


**NORTHWEST PACIFIC OCEAN  
TROPICAL CYCLONES  
21 JUL 99 - 23 AUG 99**

**MAXIMUM SUSTAINED SURFACE WIND**  
 ————— 64KT (33M/SEC) OR GREATER  
 - - - - - 34 TO 63KT (18 TO 32M/SEC)  
 ..... 33KT (17M/SEC) OR LESS

|               |                 |
|---------------|-----------------|
| 08W TD        | 21 JUL - 22 JUL |
| 09W TS NEIL   | 25 JUL - 28 JUL |
| 10W TD        | 26 JUL - 27 JUL |
| 11W TY OLGA   | 29 JUL - 03 AUG |
| 12W TS PAUL   | 03 AUG - 08 AUG |
| 13W TS RACHEL | 06 AUG - 09 AUG |
| 07E TY DORA   | 06 AUG - 23 AUG |

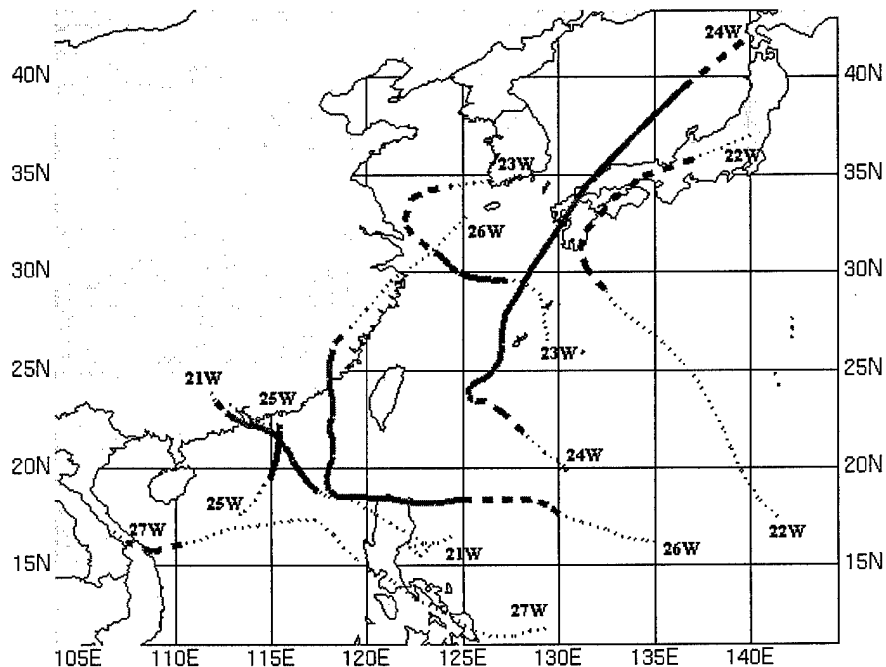




**NORTHWEST PACIFIC OCEAN  
TROPICAL CYCLONES  
08 AUG 99 - 04 SEP 99**

**MAXIMUM SUSTAINED SURFACE WIND**  
 ——— 64KT (33M/SEC) OR GREATER  
 - - - 34 TO 63KT (18 TO 32M/SEC)  
 ..... 33KT (17M/SEC) OR LESS

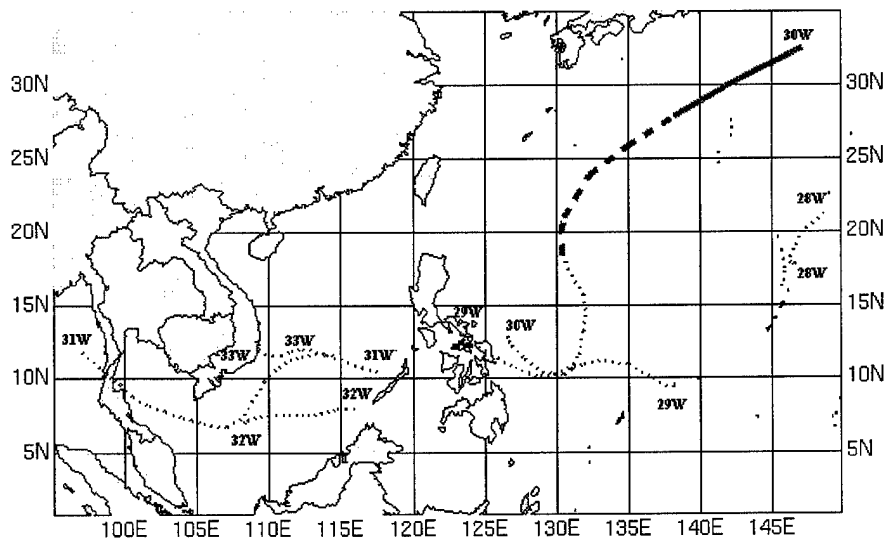
|               |                 |
|---------------|-----------------|
| 14W TD        | 08 AUG - 10 AUG |
| 15W TD        | 16 AUG - 18 AUG |
| 16W TY SAM    | 18 AUG - 23 AUG |
| 17W TY TANYA  | 19 AUG - 24 AUG |
| 18W TD        | 21 AUG - 24 AUG |
| 19W TY VIRGIL | 24 AUG - 29 AUG |
| 20W TS WENDY  | 01 SEP - 04 SEP |



NORTHWEST PACIFIC OCEAN  
TROPICAL CYCLONES  
11 SEP 99 - 19 OCT 99

MAXIMUM SUSTAINED SURFACE WIND  
 ——— 64KT (33M/SEC) OR GREATER  
 - - - - 34 TO 63KT (18 TO 32M/SEC)  
 ..... 33KT (17M/SEC) OR LESS

|              |                 |
|--------------|-----------------|
| 21W TY YORK  | 11 SEP - 17 SEP |
| 22W TS ZIA   | 13 SEP - 15 SEP |
| 23W TS ANN   | 15 SEP - 20 SEP |
| 24W STY BART | 17 SEP - 24 SEP |
| 25W TS CAM   | 23 SEP - 25 SEP |
| 26W TY DAN   | 02 OCT - 11 OCT |
| 27W TS EVE   | 15 OCT - 19 OCT |



NORTHWEST PACIFIC OCEAN  
TROPICAL CYCLONES  
05 NOV 99 - 16 DEC 99

MAXIMUM SUSTAINED SURFACE WIND  
 ——— 64KT (33M/SEC) OR GREATER  
 - - - - 34 TO 63KT (18 TO 32M/SEC)  
 ..... 33KT (17M/SEC) OR LESS

|                |                 |
|----------------|-----------------|
| 28W TD         | 05 NOV - 06 NOV |
| 29W TS FRANKIE | 06 NOV - 10 NOV |
| 30W TY GLORIA  | 13 NOV - 16 NOV |
| 31W TD         | 01 DEC - 04 DEC |
| 32W TD         | 09 DEC - 11 DEC |
| 33W TD         | 14 DEC - 16 DEC |

Table 1-6 DISTRIBUTION OF NORTHERN INDIAN OCEAN TROPICAL CYCLONES FOR 1975 - 1999

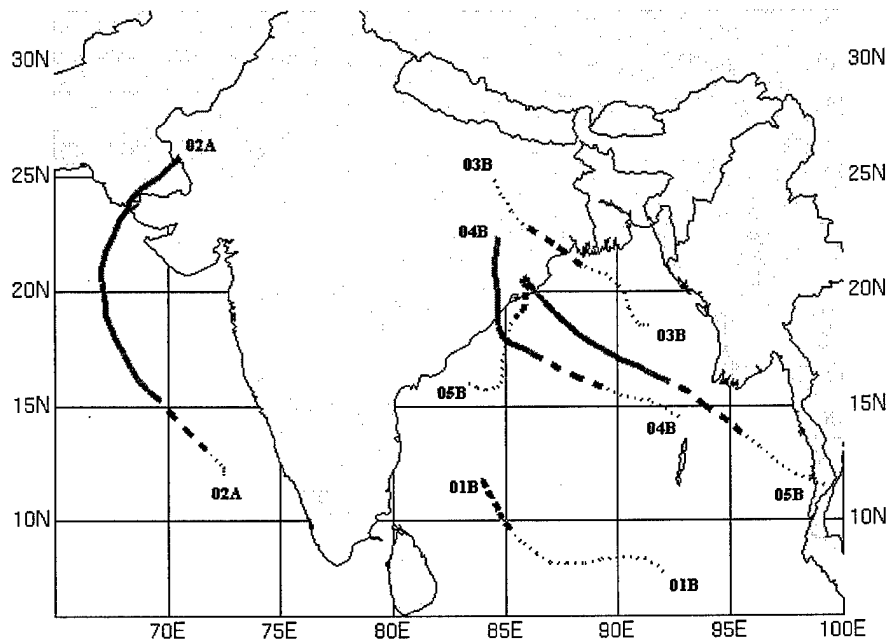
| YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | TOTALS |
|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------|
| 1975 | 1   | 0   | 0   | 0   | 2   | 0   | 0   | 0   | 0   | 1   | 2   | 0   | 6      |
|      | 010 | 000 | 000 | 000 | 200 | 000 | 000 | 000 | 000 | 100 | 020 | 000 | 3 3 0  |
| 1976 | 0   | 0   | 0   | 1   | 0   | 1   | 0   | 0   | 1   | 1   | 0   | 1   | 5      |
|      | 000 | 000 | 000 | 010 | 000 | 010 | 000 | 000 | 010 | 010 | 000 | 010 | 0 5 0  |
| 1977 | 0   | 0   | 0   | 0   | 1   | 1   | 0   | 0   | 0   | 1   | 0   | 2   | 5      |
|      | 000 | 000 | 000 | 000 | 010 | 010 | 000 | 000 | 000 | 010 | 000 | 110 | 1 4 0  |
| 1978 | 0   | 0   | 0   | 0   | 1   | 0   | 0   | 0   | 0   | 1   | 2   | 0   | 4      |
|      | 000 | 000 | 000 | 000 | 010 | 000 | 000 | 000 | 000 | 010 | 200 | 000 | 2 2 0  |
| 1979 | 0   | 0   | 0   | 0   | 1   | 1   | 0   | 0   | 2   | 1   | 2   | 0   | 7      |
|      | 000 | 000 | 000 | 000 | 100 | 010 | 000 | 000 | 011 | 010 | 011 | 000 | 1 4 2  |
| 1980 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1   | 2      |
|      | 000 | 000 | 000 | 000 | 000 | 000 | 000 | 000 | 000 | 000 | 010 | 010 | 0 2 0  |
| 1981 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 0   | 1   | 1   | 3      |
|      | 000 | 000 | 000 | 000 | 000 | 000 | 000 | 000 | 010 | 000 | 100 | 100 | 2 1 0  |
| 1982 | 0   | 0   | 0   | 0   | 1   | 1   | 0   | 0   | 0   | 2   | 1   | 0   | 5      |
|      | 000 | 000 | 000 | 000 | 100 | 010 | 000 | 000 | 000 | 020 | 100 | 000 | 2 3 0  |
| 1983 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 0   | 1   | 1   | 0   | 3      |
|      | 000 | 000 | 000 | 000 | 000 | 000 | 000 | 010 | 000 | 010 | 010 | 000 | 0 3 0  |
| 1984 | 0   | 0   | 0   | 0   | 1   | 0   | 0   | 0   | 0   | 1   | 2   | 0   | 4      |
|      | 000 | 000 | 000 | 000 | 010 | 000 | 000 | 000 | 000 | 010 | 200 | 000 | 2 2 0  |
| 1985 | 0   | 0   | 0   | 0   | 2   | 0   | 0   | 0   | 0   | 2   | 1   | 1   | 6      |
|      | 000 | 000 | 000 | 000 | 020 | 000 | 000 | 000 | 000 | 020 | 010 | 010 | 0 6 0  |
| 1986 | 1   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 2   | 0   | 3      |
|      | 010 | 000 | 000 | 000 | 000 | 000 | 000 | 000 | 000 | 000 | 020 | 000 | 0 3 0  |
| 1987 | 0   | 1   | 0   | 0   | 0   | 2   | 0   | 0   | 0   | 2   | 1   | 2   | 8      |
|      | 000 | 010 | 000 | 000 | 000 | 020 | 000 | 000 | 000 | 020 | 010 | 020 | 0 8 0  |
| 1988 | 0   | 0   | 0   | 0   | 0   | 1   | 0   | 0   | 0   | 1   | 2   | 1   | 5      |
|      | 000 | 000 | 000 | 000 | 000 | 010 | 000 | 000 | 000 | 010 | 110 | 010 | 1 4 0  |
| 1989 | 0   | 0   | 0   | 0   | 1   | 1   | 0   | 0   | 0   | 0   | 1   | 0   | 3      |
|      | 000 | 000 | 000 | 000 | 010 | 010 | 000 | 000 | 000 | 000 | 100 | 000 | 1 2 0  |
| 1990 | 0   | 0   | 0   | 1   | 1   | 0   | 0   | 0   | 0   | 0   | 1   | 1   | 4      |
|      | 000 | 000 | 000 | 001 | 100 | 000 | 000 | 000 | 000 | 000 | 001 | 010 | 1 1 2  |
| 1991 | 1   | 0   | 0   | 1   | 0   | 1   | 0   | 0   | 0   | 0   | 1   | 0   | 4      |
|      | 010 | 000 | 000 | 100 | 000 | 010 | 000 | 000 | 000 | 000 | 100 | 000 | 1 3 0  |
| 1992 | 0   | 0   | 0   | 0   | 1   | 2   | 1   | 0   | 1   | 3   | 3   | 2   | 13     |
|      | 000 | 000 | 000 | 000 | 100 | 020 | 010 | 000 | 001 | 021 | 210 | 020 | 3 8 2  |
| 1993 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 2   | 0   | 2      |
|      | 000 | 000 | 000 | 000 | 000 | 000 | 000 | 000 | 000 | 000 | 200 | 000 | 2 0 0  |
| 1994 | 0   | 0   | 1   | 1   | 0   | 1   | 0   | 0   | 0   | 1   | 1   | 0   | 5      |
|      | 000 | 000 | 010 | 100 | 000 | 010 | 000 | 000 | 000 | 010 | 010 | 000 | 1 4 0  |
| 1995 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 1   | 1   | 2   | 0   | 4      |
|      | 000 | 000 | 000 | 000 | 000 | 000 | 000 | 000 | 010 | 010 | 200 | 000 | 2 2 0  |
| 1996 | 0   | 0   | 0   | 0   | 1   | 3   | 0   | 0   | 0   | 2   | 2   | 0   | 8      |
|      | 000 | 000 | 000 | 000 | 010 | 120 | 000 | 000 | 000 | 110 | 200 | 000 | 4 4 0  |

Table 1-6 DISTRIBUTION OF NORTHERN INDIAN OCEAN TROPICAL CYCLONES FOR 1975 - 1999

|             |     |     |     |     |     |     |     |     |     |     |     |     |             |
|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------------|
| 1997        | 0   | 0   | 0   | 0   | 1   | 0   | 0   | 0   | 1   | 1   | 1   | 0   | 4           |
|             | 000 | 000 | 000 | 000 | 100 | 000 | 000 | 000 | 100 | 010 | 010 | 000 | 2 2 0       |
| 1998        | 0   | 0   | 0   | 0   | 2   | 1   | 0   | 0   | 1   | 1   | 2   | 1   | 8           |
|             | 000 | 000 | 000 | 000 | 110 | 100 | 000 | 000 | 010 | 010 | 200 | 100 | 5 3 0       |
| 1999        | 0   | 1   | 0   | 0   | 1   | 1   | 0   | 0   | 0   | 2   | 0   | 0   | 5           |
|             | 000 | 010 | 000 | 000 | 100 | 010 | 000 | 000 | 000 | 200 | 000 | 000 | 3 2 0       |
| (1975-1999) |     |     |     |     |     |     |     |     |     |     |     |     |             |
| MEAN        | 0.1 | 0.1 | 0.1 | 0.2 | 0.6 | 0.6 | 0.1 | 0.1 | 0.3 | 1.0 | 1.3 | 0.5 | 5           |
|             |     |     |     |     |     |     |     |     |     |     |     |     | 1.6 3.2 0.2 |
| CASES       | 3   | 2   | 1   | 4   | 15  | 14  | 1   | 1   | 8   | 26  | 32  | 13  | 126         |
|             |     |     |     |     |     |     |     |     |     |     |     |     | 39 80 6     |

The criteria used in TABLE 1-6 are as follows:

- 1) If a tropical cyclone was first warned on during the last two days of a particular month and continued into the next month for longer than two days, then that system was attributed to the second month.
- 2) If a tropical cyclone was warned on prior to the last two days of a month, it was attributed to the first month, regardless of how long the system lasted.
- 3) If a tropical cyclone began on the last day of the month and ended on the first day of the next month, that system was attributed to the first month. However, if a tropical cyclone began on the last day of the month and continued into the next month for only two days, then it was attributed to the second month.



ARABIAN SEA / BAY OF BENGAL  
TROPICAL CYCLONES  
02 FEB 99 - 01 NOV 99

MAXIMUM SUSTAINED SURFACE WIND  
 ——— 64KT (33M/SEC) OR GREATER  
 - - - - 34 TO 63KT (18 TO 32M/SEC)  
 ..... 33KT (17M/SEC) OR LESS

TC 01 02 FEB - 04 FEB  
 TC 02 16 MAY - 21 MAY  
 TC 03 10 JUN - 11 JUN  
 TC 04 15 OCT - 18 OCT  
 TC 05 26 OCT - 01 NOV

## Tropical Storm Hilda (01W)

Tropical Storm (TS) Hilda (01W) was the first tropical cyclone as well as the first named system in the 1999 season. This cyclone formed off the northwest coast of Borneo and reached a maximum intensity of 35 kt before dissipating over water in the South China Sea at 071200Z January. Six fatalities were attributed to the heavy rains of TS Hilda in Malaysia.

JTWC issued a Tropical Cyclone Formation Alert at 040230Z January on a broad circulation which extended off the northwest coast of Borneo into the South China Sea. The first warning was issued at 040900Z January as a 25 kt cyclone. Tropical Storm Hilda (01W) drifted slowly northward at 4 kt within the broad depression north of Borneo and reached tropical storm intensity at 061800Z January. Soon after reaching its maximum intensity of 35 knots, TS Hilda (01W) drifted into an area of increased vertical wind shear and dissipated over water. JTWC issued the 12th and final warning at 070300Z January.

The Country report of Malaysia from the 32nd Session ESCAP/WMO Typhoon Committee 1999 stated "...Hilda brought heavy rain to Sabah state causing severe flooding and landslide occurrences leading to six deaths."

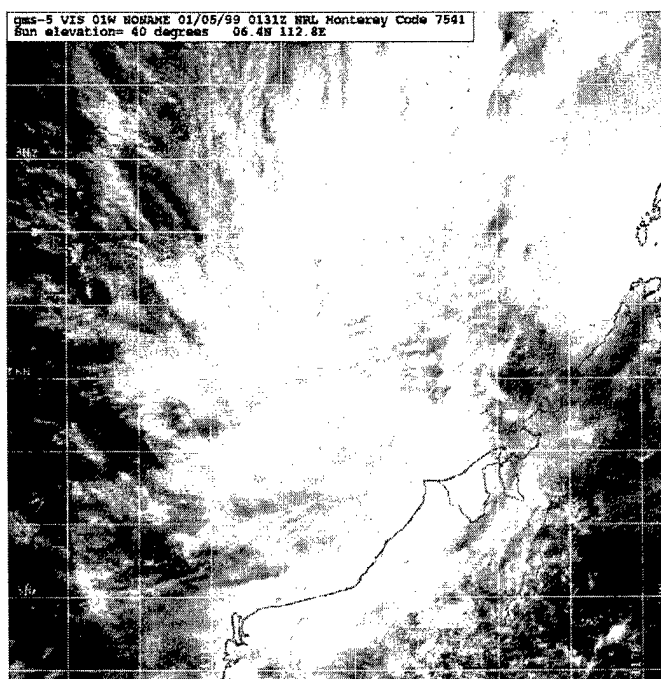
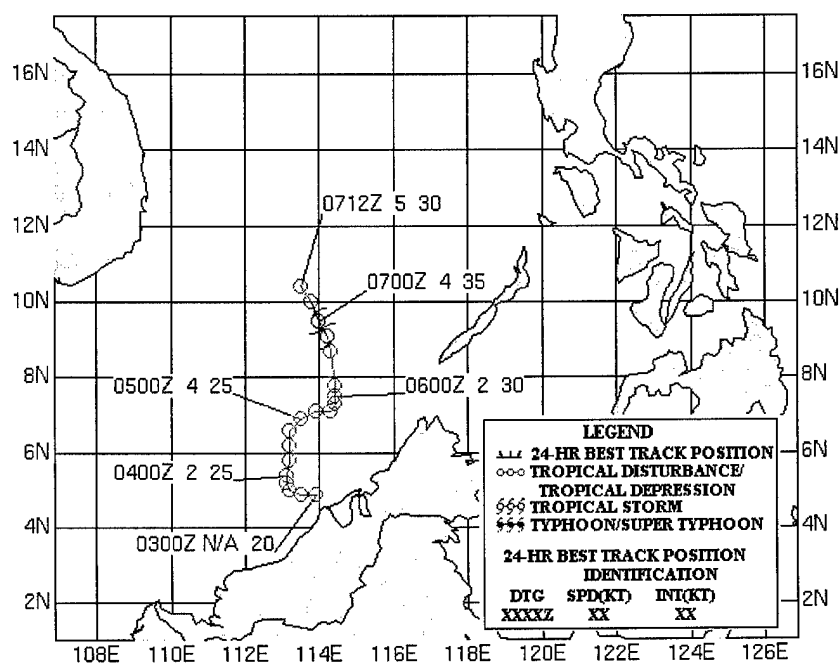


Figure 1-01-1. A visible satellite image showing TD 01W embedded in a large area of convection off the northwest coast of Borneo.

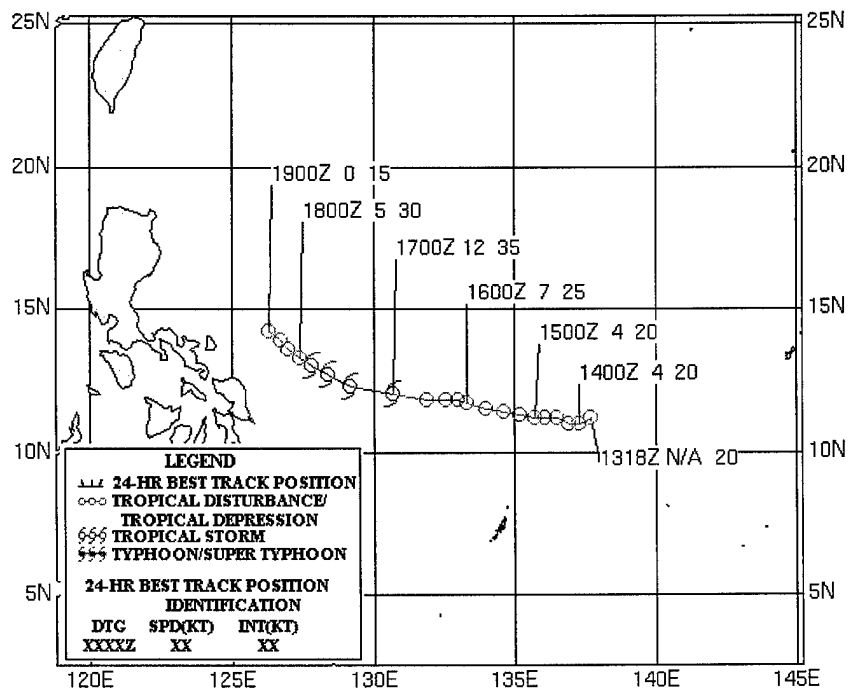




## Tropical Storm Iris (02W)

Tropical Storm (TS) Iris (02W) formed in mid-February from a monsoon depression in the Philippine Sea. TS Iris reached a peak intensity of 35 kt as it tracked westward toward the Philippine Islands and dissipated after 6 days in the Philippine Sea.

A TCFA was issued on the monsoon depression approximately 400 nm west-southwest of Guam, at 132330Z February. The depression was slow to consolidate and JTWC issued two subsequent TCFA's (142330Z and 152330Z) before issuing the first tropical cyclone warning on TD 02W on 160000Z February. TD 02W tracked westward toward the Philippines until 170000Z February when it reached tropical storm strength. TS Iris then moved more northwestward in response to the subtropical ridge to the east. TS Iris attained a maximum intensity of 35 kt and then began to weaken over water, due to strong vertical wind shear. JTWC issued the 13th and final warning on TS Iris at 181800Z February as the cyclone dissipated 120 nm east of the Philippine Islands.



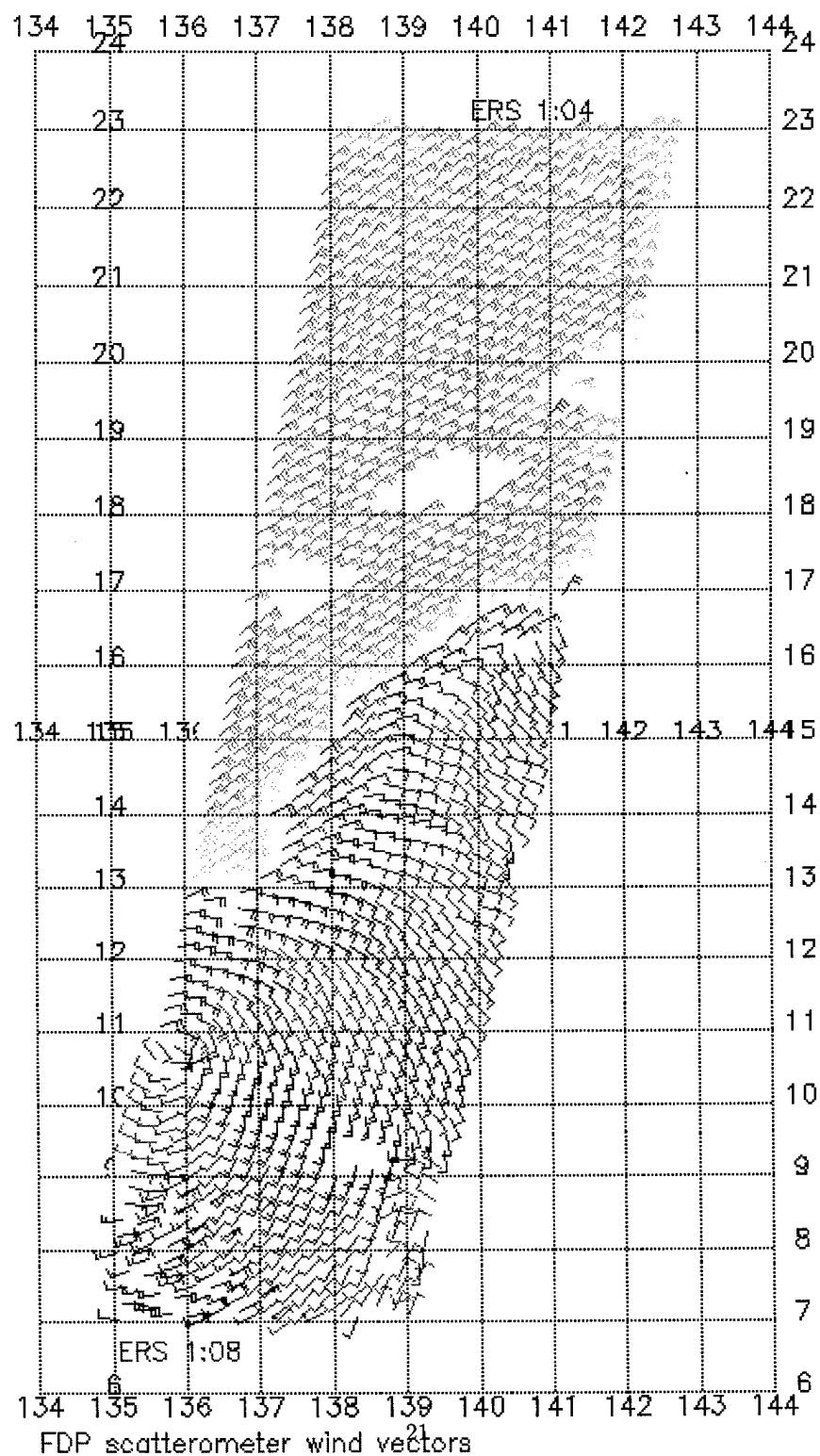


Figure 1-02-1. ERS-2 Scatterometer pass over Tropical Depression 02W which later developed into TS Iris. The low level circulation center seems to be enhanced due to horizontal wind shear from the strong northeasterly monsoon.

## Tropical Storm Jacob (03W)

Tropical Storm (TS) Jacob (03W) was the third tropical cyclone as well as the third named storm of the 1999 season. This cyclone formed 120 nm west of Yap and reached a maximum intensity of 35 kt before making landfall on the southeast corner of Luzon, near Virac, Province of Cataduanes, at 091800Z April.

JTWC issued a Tropical Cyclone Formation Alert at 060330Z April on a low pressure area which displayed distinct cloud lines moving into a broad center (see Figure 1-03-1). The first warning for TD 03W was issued at 060900Z April as a 25 kt cyclone. Tropical Storm Jacob initially moved northward and then westward under the steering influence of a subtropical ridge located to its north.

As the cyclone slowly intensified to a 30 knot system, it began to accelerate as it reached its maximum intensity of 35 knots at 081800Z April. As TS Jacob reached its maximum intensity it began to enter a region of moderate to severe vertical wind shear. Subsequently, TS Jacob became a totally exposed low level circulation by 082330Z April (see Figure 1-03-2), and weakened before making landfall on the southeast coast of Luzon. JTWC issued the 16th and final warning at 100300Z April.

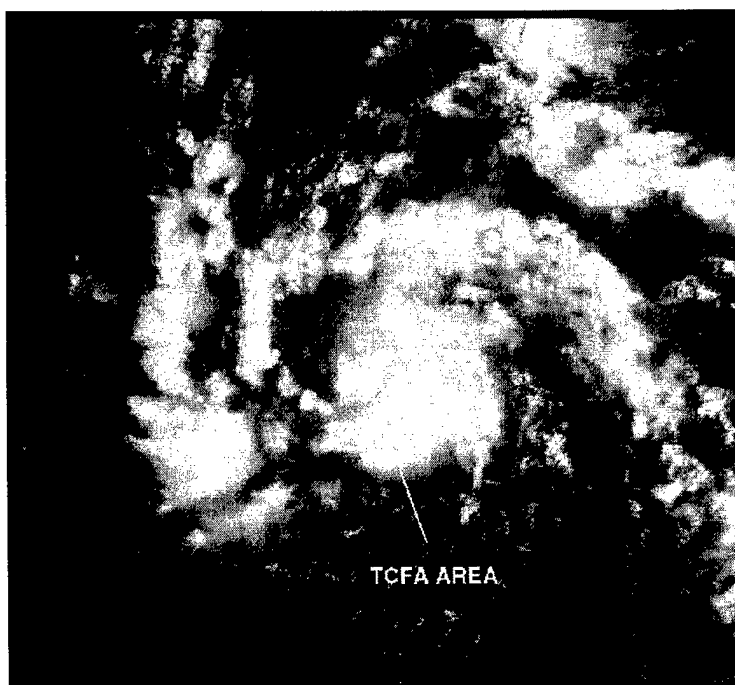


Figure 1-03-1. An infrared satellite image of the tropical disturbance which would become TS Jacob (03W).

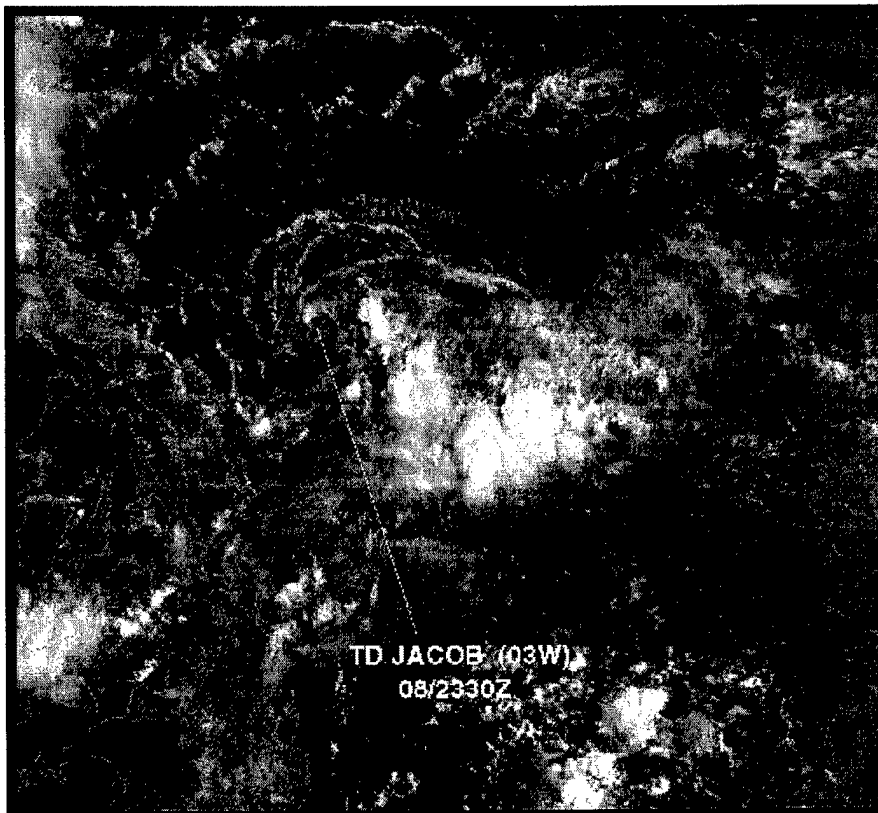
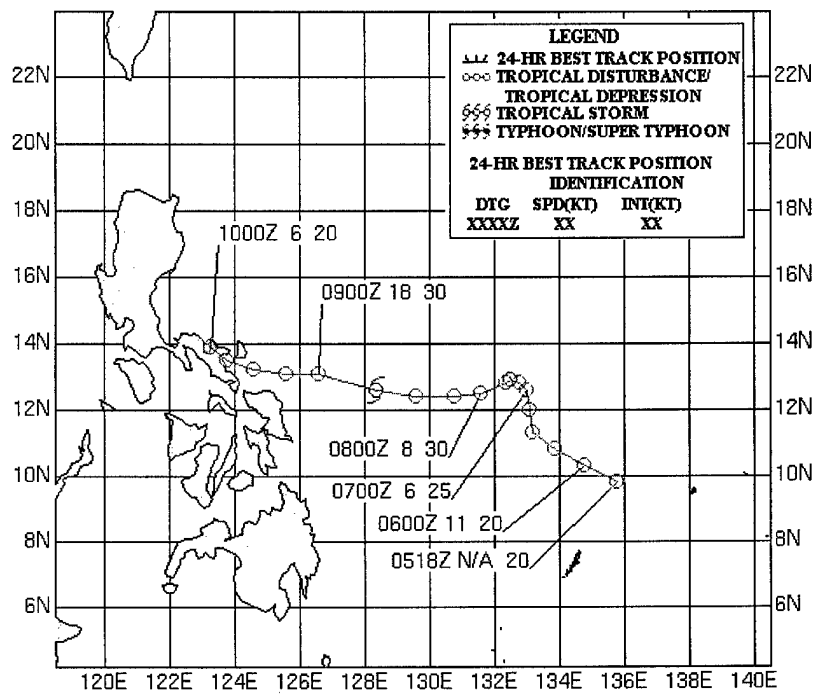


Figure 1-03-2. A visible satellite image of TD JACOB (03W) as it became a fully exposed low-level circulation just east of the Philippines.



## Typhoon Kate (04W)

Typhoon Kate (04W) was the first 1999 cyclone to reach typhoon intensity. JTWC issued the first warning on this cyclone as a tropical depression while it was over Mindanao on 18 April. TY Kate initially moved northward then northeastward around the northern periphery of the subtropical ridge within the deep westerlies flow regime. TY Kate reached a max intensity of 75 kt and tracked 5 nm north of Iwo Jima, Japan. Observations from Iwo Jima included gusts to 68 kt. TY Kate later transitioned to an extratropical system well to the east of Honshu.

JTWC first mentioned the disturbance on the 180600Z April ABPW while it was in the Philippine Sea. As it drifted westward in the low-level flow it moved over Mindanao, Philippines on 20 April. Although it was over land, JTWC forecasters identified a slight intensification through synoptic data and satellite analysis. As such, JTWC issued a Tropical Cyclone Formation Alert at 210930Z April. The disturbance continued to slowly intensify and JTWC issued the first warning with a maximum intensity of 25 kt at 220300Z April, still over land.

During the first 24 hours, TD 04W tracked northward under the steering influence of the subtropical ridge to the east. On 230000Z April, the cyclone slowed and began to consolidate reaching tropical storm intensity. Initially the cyclone was forecast to intensify slightly and track north-northeastward and dissipate in a region of strong vertical windshear due to interaction with a mid-latitude frontal boundary. As it tracked further north and moved around the ridge axis it moved within the deep steering flow north of the ridge axis. As such, the vertical structure was all westerly flow and resultant windshear was minimal. The lack of windshear allowed TY Kate to continue to intensify as it remained embedded in the predominant westerly flow.

Visible imagery indicated TY Kate had developed an eye at 262330Z (Figure 1-04-1). Afterwards, a Tropical Rainfall Measurement Mission (TRMM) pass became available and indicated an eye was forming at 261800Z (Figure 1-04-2). A few hours later, a 262200Z Special Sensor Microwave/Imager (SSM/I) pass (Figure 1-04-3) indicated TY Kate had weakened, but still maintained a well defined eye. TY Kate tracked 5nm north of Iwo Jima, Japan on 271000Z Apr as a 70 kt system. Post analysis established peak intensity (75 kt) at 261800Z April as it continued to accelerate northeastward. TY Kate continued to accelerate east-northeastward and weaken (Figure 1-04-4) losing most of its convection by 271700Z (Figure 1-04-5/6). JTWC issued the 27th and final warning at 281500Z April as it become an extratropical system (Figure 1-04-7).

Observations from Iwo Jima included peak 10 minute sustained winds of 40 kt (50 kt 1 minute average) with 68 kt gusts. TY Kate was a 70 kt system as it tracked about 5 nm north of Iwo Jima. No damage reports were available.

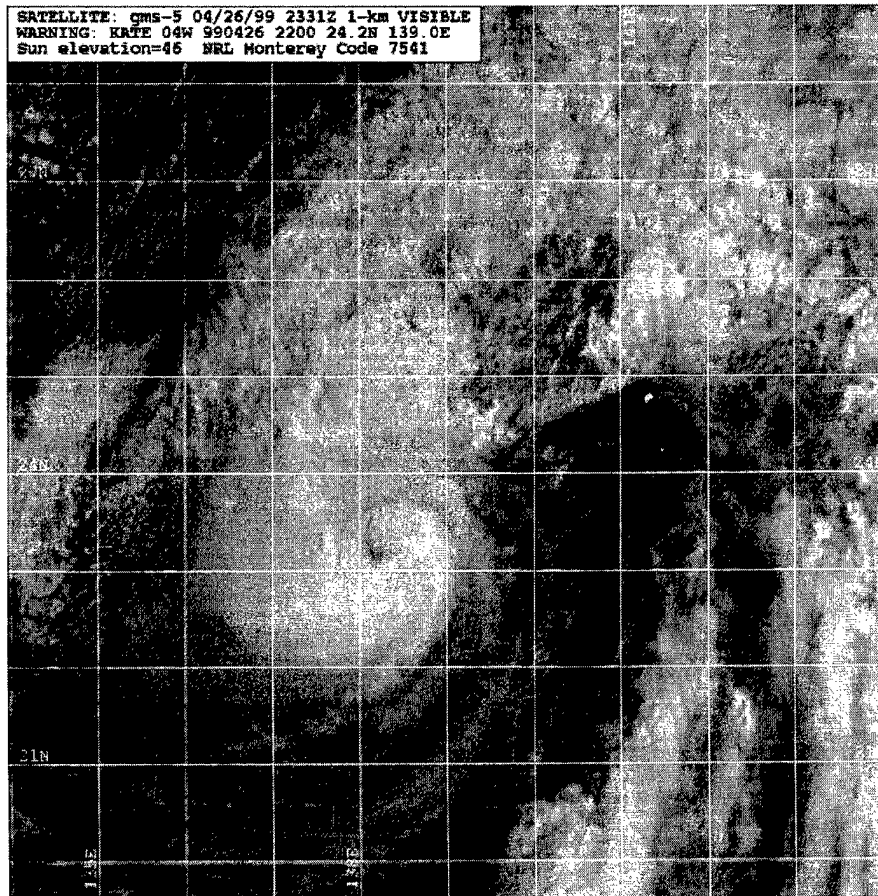


Figure 1-04-1. 262330Z April GMS-5 visible image of TY Kate. TY Kate was at it's max intensity (75 kt).

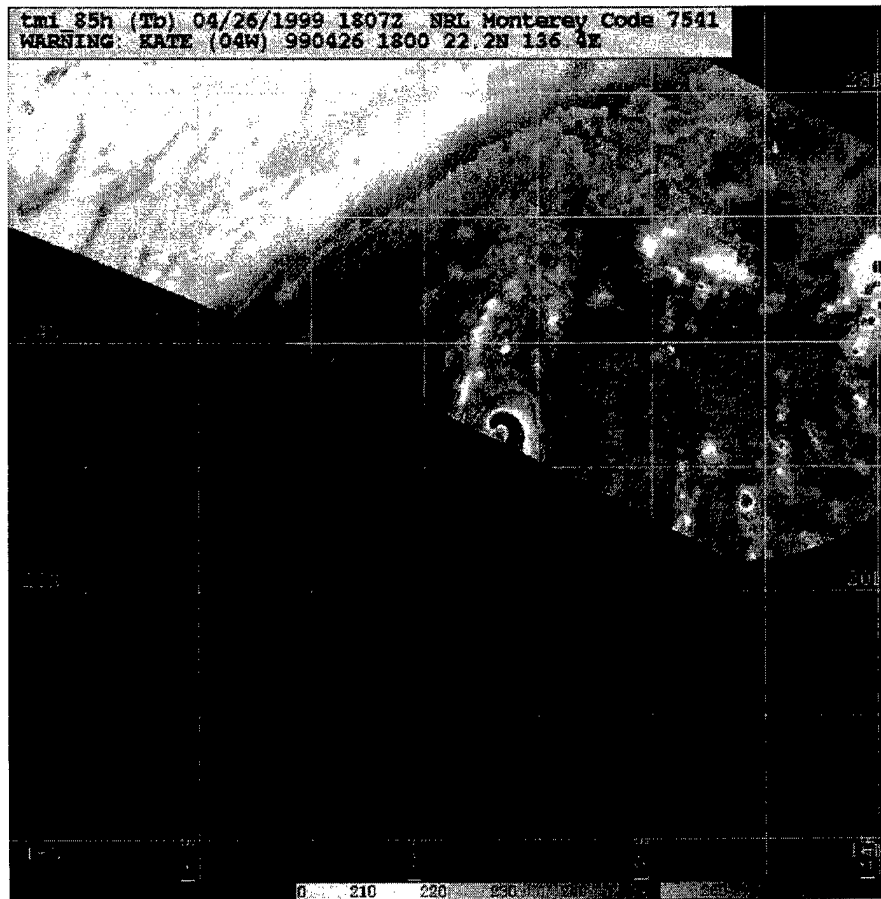


Figure 1-04-2. 261807Z April Tropical Rainfall Measurement Mission (TRMM) pass shows a very distinct spiral band and possible eyewall. TY Kate was at it's max intensity (75 kt).



SATELLITE: f11 1999 04 26 2158Z 85 GHZ H (Brightness Temperature)  
WARNING: KATE (04W) 990426 2200 24.2N 139.0E  
NRL Monterey Code 7541

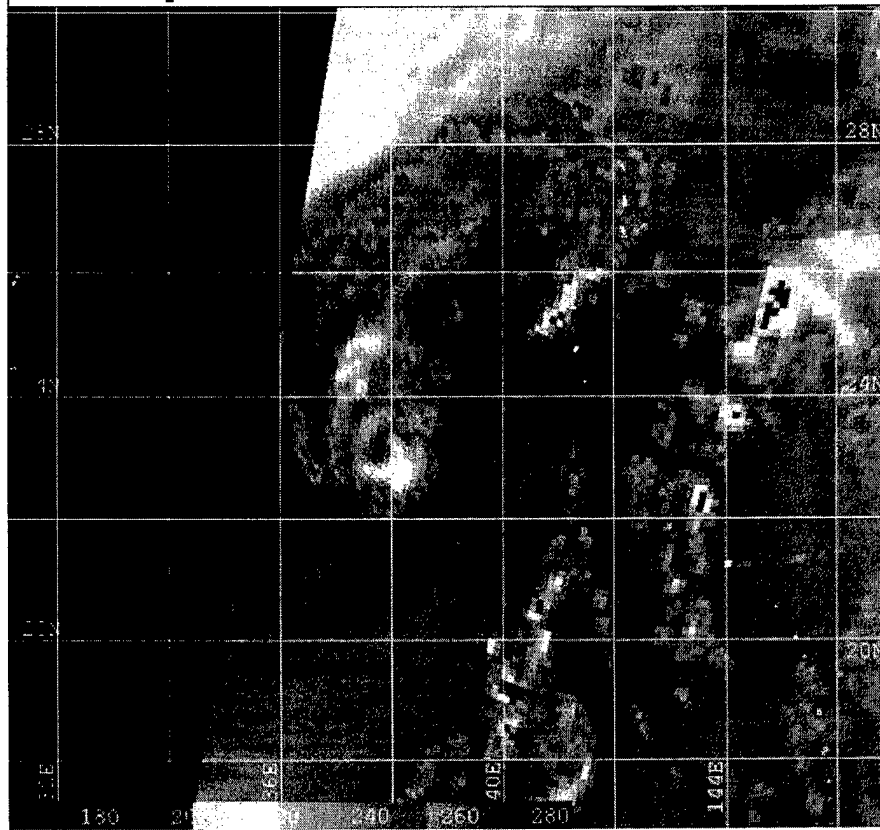


Figure 1-04-3. 262200Z April Special Sensor Microwave/Imager (SSM/I) pass reveals a distinct eye with max convection in the southeast quadrant.

SATELLITE: f11 1999 04 27 0900Z 85 GHZ H (Brightness Temperature)  
 WARNING: KATE (04W) 990427 0600 24.0N 140.0E  
 NRL Monterey Code 7541

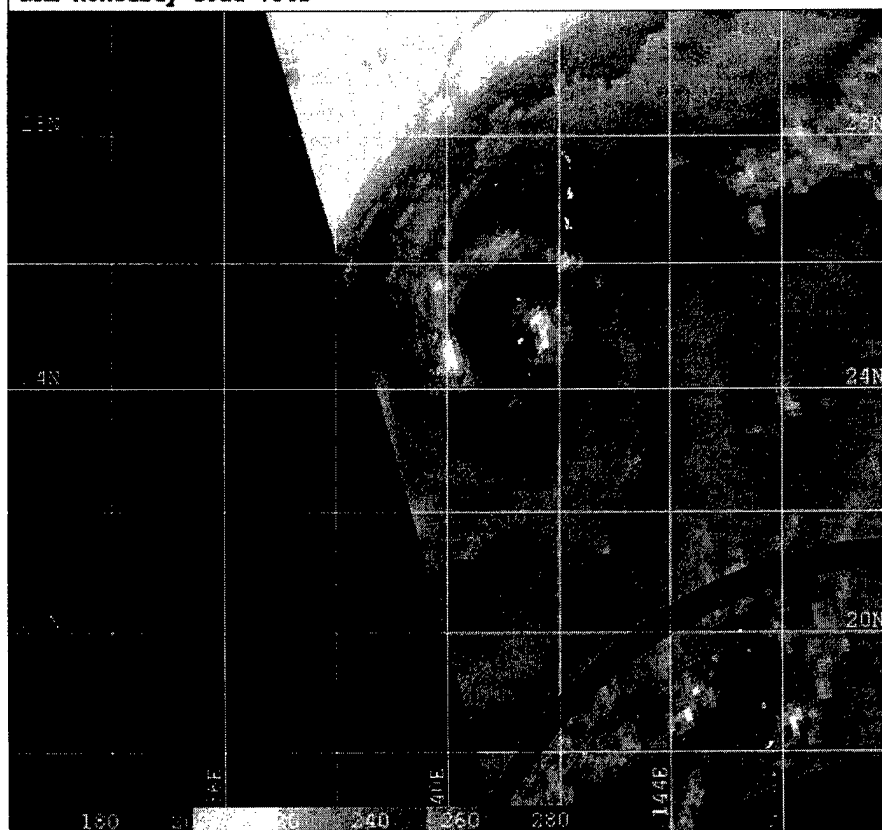


Figure 1-04-4. 270900Z April SSM/I pass shows convection now limited to the east side.

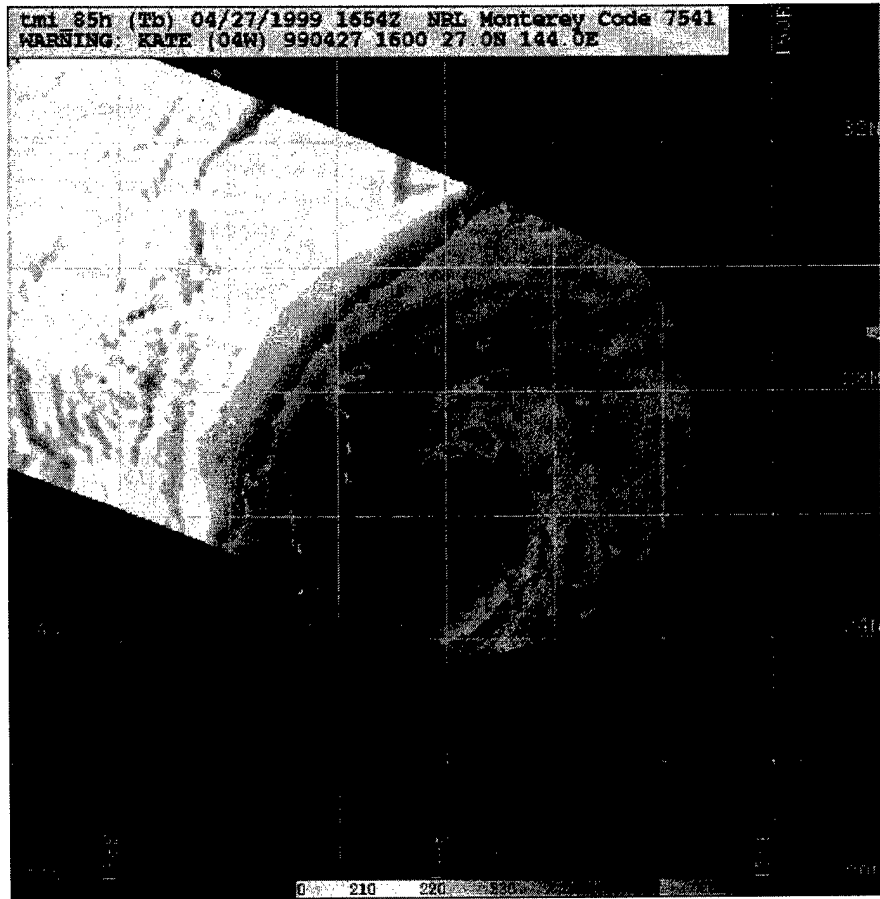


Figure 1-04-5. 271654Z April TRMM pass indicates deep convection has dissipated.

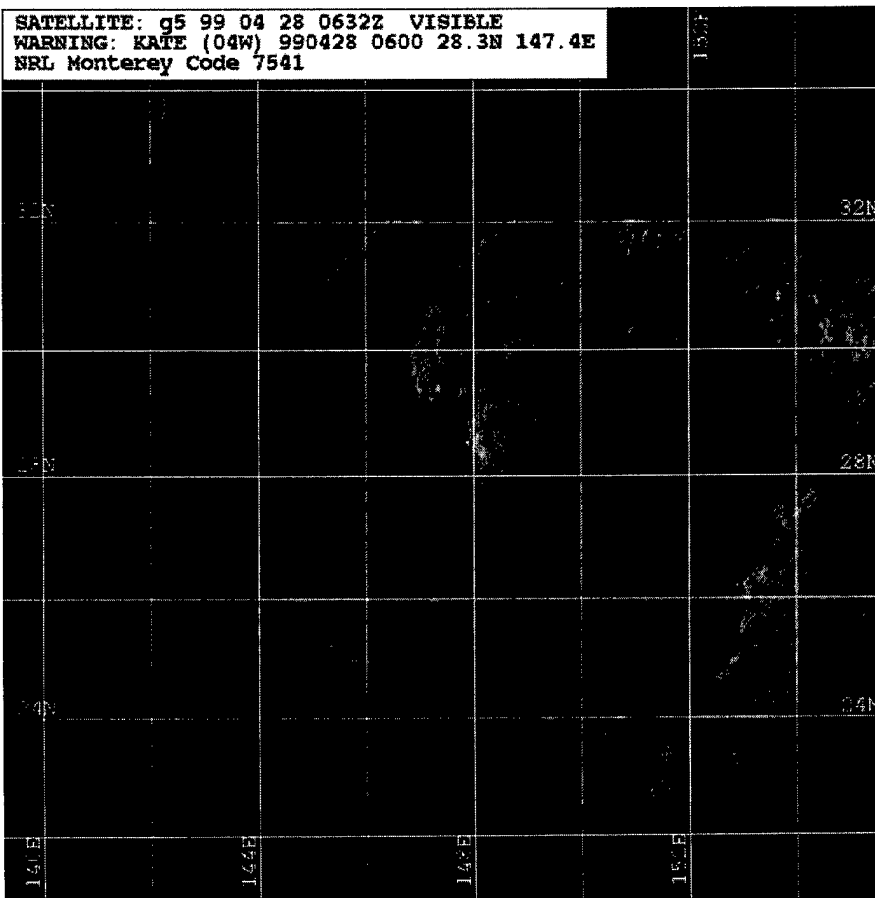


Figure 1-04-6. 280632Z April GMS-5 visible image indicates the system is elongating and transitioning to an extratropical system.

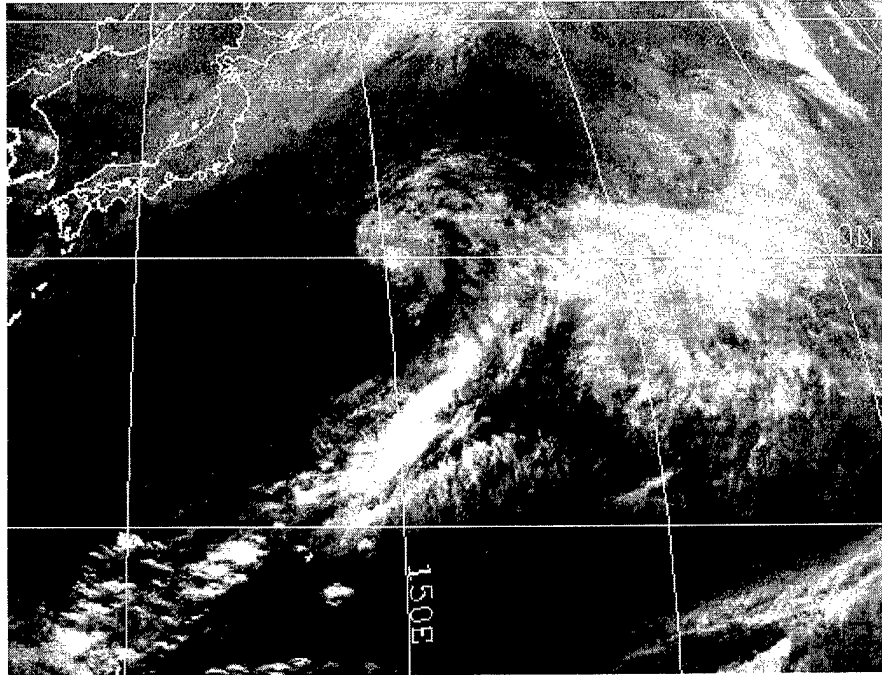
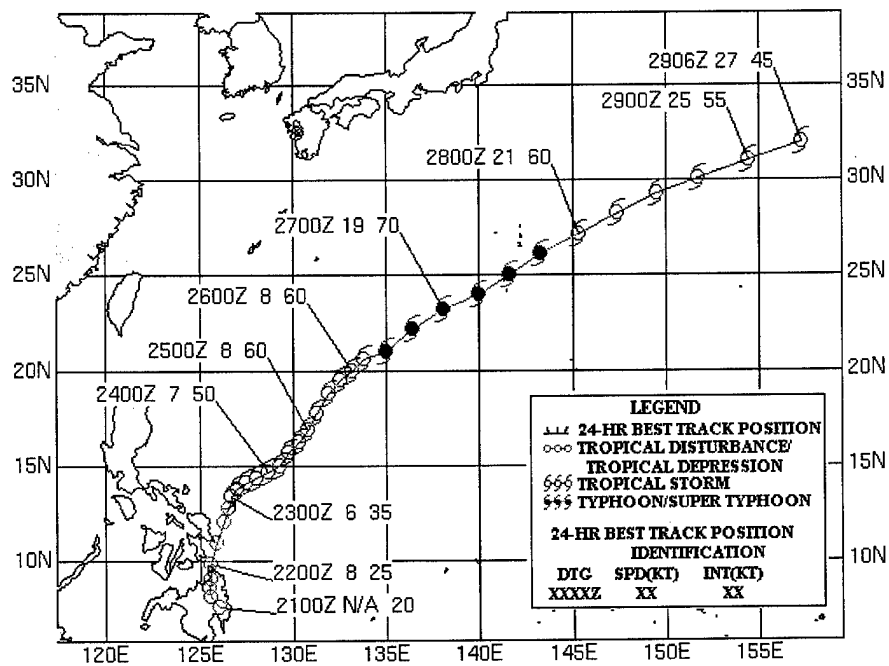


Figure 1-04-7. 281130Z April GMS-5 infrared image as TS Kate transitions to an extratropical system.



## Typhoon Leo (05W)

Typhoon (TY) Leo (05W) developed off the coast of Vietnam and became the first tropical cyclone to threaten Hong Kong during the 1999 season. TY Leo (05W) peaked at 110 kt before weakening and making landfall with minimal effects on Hong Kong.

Typhoon Leo (05W) formed slowly in the South China Sea in late April. The cyclone formed within a broad monsoon depression off the coast of Vietnam partially due to enhanced southwesterly flow into the South China Sea caused by Typhoon Kate (04W) located in the Philippine Sea. Noting the increased winds and cyclonic shear in the area, JTWC added the disturbance which would become TY Leo to the Significant Tropical Weather Advisory (ABPW) at 251300Z April.

Within 24 hours, a broad circulation began to form and JTWC issued a Tropical Cyclone Formation Alert at 261030Z April. At 270300Z April, 25 kt winds were reported on the periphery of a very broad circulation and JTWC issued the first warning. As is the case with most monsoon depressions, the higher winds remained on the periphery of the broad circulation for several days. Since the winds near the center of the circulation were very light, locating the center was very difficult resulting in several relocations.

By 280600Z April, TD 05W intensified while moving westward and was upgraded to Tropical Storm Leo (05W). However, at 281800Z April, it became evident that the low-level circulation was moving in a cyclonic loop off the coast of Vietnam and the convection which was previously headed westward toward Vietnam was now moving northeast and consolidating. As the convection consolidated around a well-defined low-level circulation center, TS Leo began to rapidly intensify and attained typhoon intensity at 291800Z April.

Typhoon Leo (05W) formed directly below a relatively narrow 200 mb ridge. The ridge reduced the vertical wind shear affecting the cyclone, but the narrow nature of the ridge allowed for very good outflow north of the cyclone. Hence, TY Leo intensified quickly as it tracked northeastward at around 6 kt and reached a maximum intensity of 110 kt by 301800Z April. Although the thin ridge helped the rapid intensification, it also caused a rapid weakening of TY Leo. After TY Leo peaked, it moved north of the 200 mb ridge and quickly entered a high vertical shear environment. The low-level flow took TY Leo westward while the 500 mb and higher level flow pushed the cyclone to the northeast. Subsequently, the cyclone began to shear apart and weaken rapidly while moving to the north.

During the 36 hours prior to landfall, the low-level circulation became totally disconnected from the deep convection and tracked more northwestward and then north as it made landfall. TY Leo struck about 35 nm east of Hong Kong as a 30 kt system with minimal impact on the Hong Kong area. JTWC issued the 24th and final warning on 022100Z May.

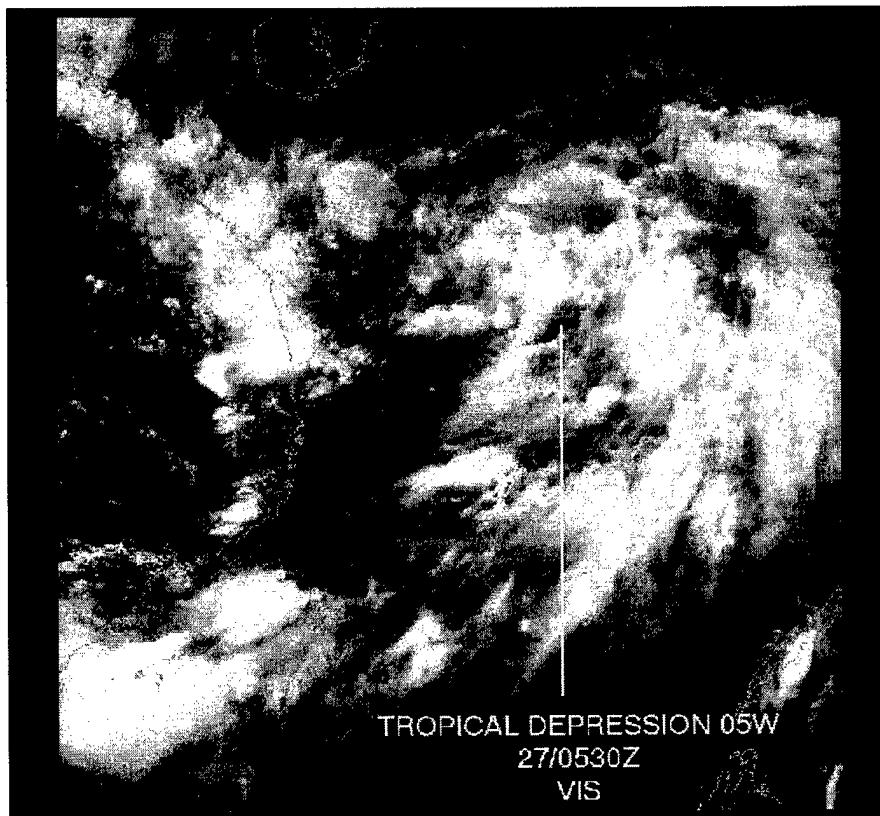


Figure 1-05-1. A visual image of TD 05W (25kt) at 270530Z April, off the east coast of Vietnam.



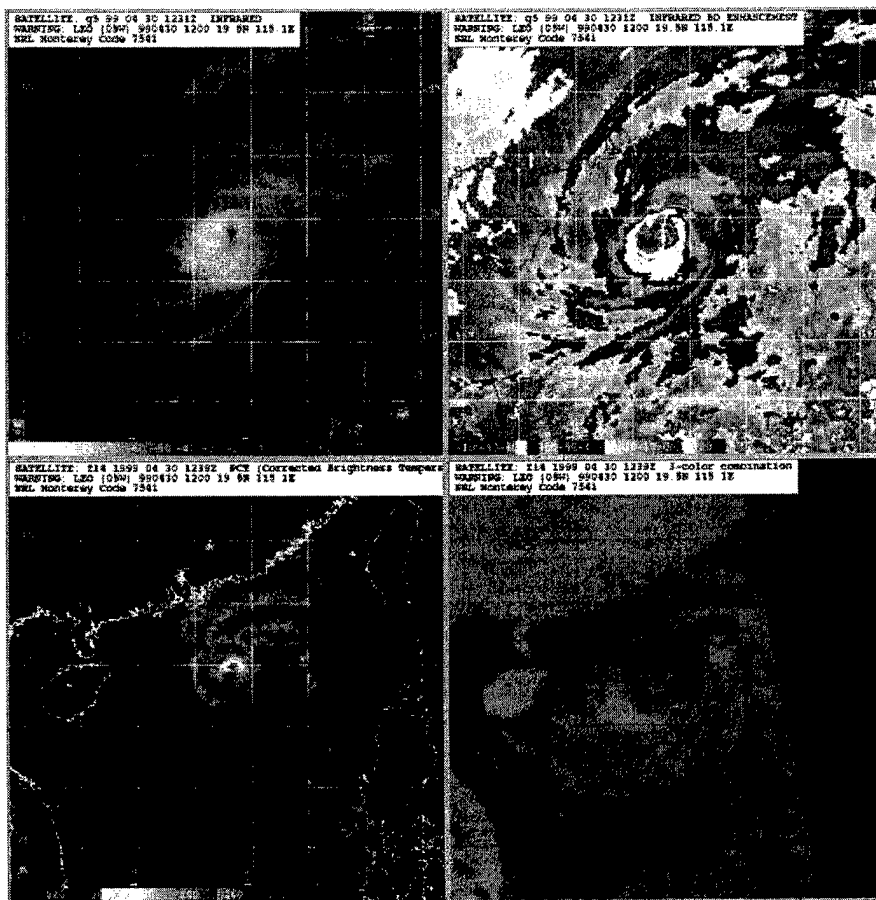
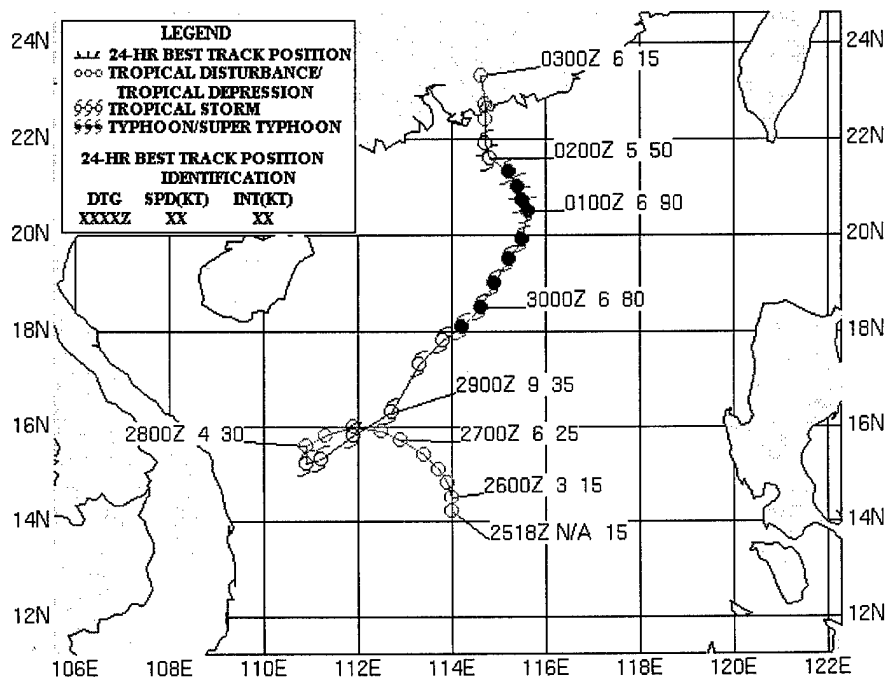


Figure 1-05-2. A 301239Z April multi-image mosaic from NRL including infrared imagery (top left and right) and Special Sensor Microwave Imagery (SSM/I) of Typhoon Leo (05W) at 105 kt intensity, 140 nm south of Hong Kong. TY Leo (05W) peaked six hours later at 110 kt.



## Typhoon Maggie (06W)

Typhoon (TY) Maggie (06W) formed east of the Philippines in the monsoon trough on the first day of June. Typhoon Maggie tracked toward the Philippines attaining a peak intensity of 105 kt east of Iligan Point, Luzon, Philippines. TY Maggie made landfall in southeastern China, approximately 55 nm east-northeast of Hong Kong and skirted along the coast before turning inland and dissipating on 08 June. TY Maggie (06W) left a trail of damage and fatalities from the Philippines to China.

TY Maggie (06W) developed in the monsoon trough extending from Southeast Asia into the Philippine Sea and genesis was aided by strong, moist cross-equatorial inflow. As satellite analysis indicated an increase in the organization of thunderstorms in the area, JTWC issued a TCFA at 010100Z June. As the cyclone continued moving slowly northward, JTWC issued the first tropical cyclone warning at 25 kt intensity eight hours later. This cyclone intensified at a faster-than-climatological rate, achieving tropical storm intensity at 020000Z and typhoon intensity later the same day at 021800Z. At 030032Z the first satellite position and intensity estimate report was received indicating a possible banding eye forming in the deep convection surrounding the system center.

As TY Maggie (06W) intensified, the subtropical ridge to the north became the dominant steering influence, adding a westward component to its previous northward track. TY Maggie peaked in intensity on 050000Z June at 105 knots before entering the Luzon Strait. From 051800Z through 060000Z TY Maggie tracked to the northwest, due to a combination of the increased steering provided by the subtropical ridge and the influence of Taiwan's terrain. Subsequently, the subtropical ridge steered TY Maggie westward toward the coast of southeastern China, approximately 55 nm east-northeast of Hong Kong, where it made landfall at 061200Z June as an 80 kt typhoon. TY Maggie spent its final 24 hours as a significant tropical cyclone moving along the coast of southern China and into the mouth of the Pearl River passing 5 km northwest of the Hong Kong Observatory at around 0400 local, producing winds near 50 kt at Hong Kong.

JTWC issued the 24th and final warning at 070300Z June as TY Maggie weakened and was forecast to turn inland and dissipate. Damage estimates from the system included 3 fatalities due to rain-induced landslides in the Philippines, 1 fatality and 5 missing in Taiwan, and \$4.8 million dollars worth of agriculture damaged in southern China.

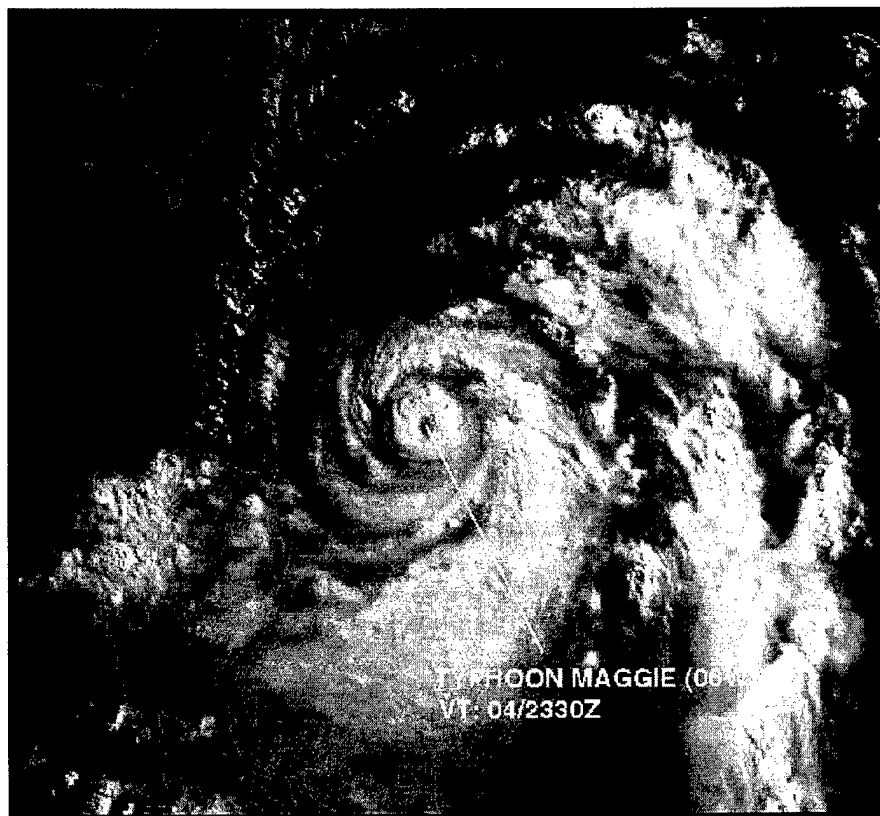


Figure 1-06-1. 042330Z June GMS-5 visible imagery of Typhoon Maggie (06W) prior to achieving its peak intensity (105 kt) northeast of Luzon; note the strong southeasterly cross-equatorial inflow.

SATELLITE: f11 1999 06 05 1016Z 85 GHZ H (Brightness Temperature)  
WARNING: MAGGIE (06W) 990604 2300 19.5N 124.0E  
NEL Monterey Code 7541

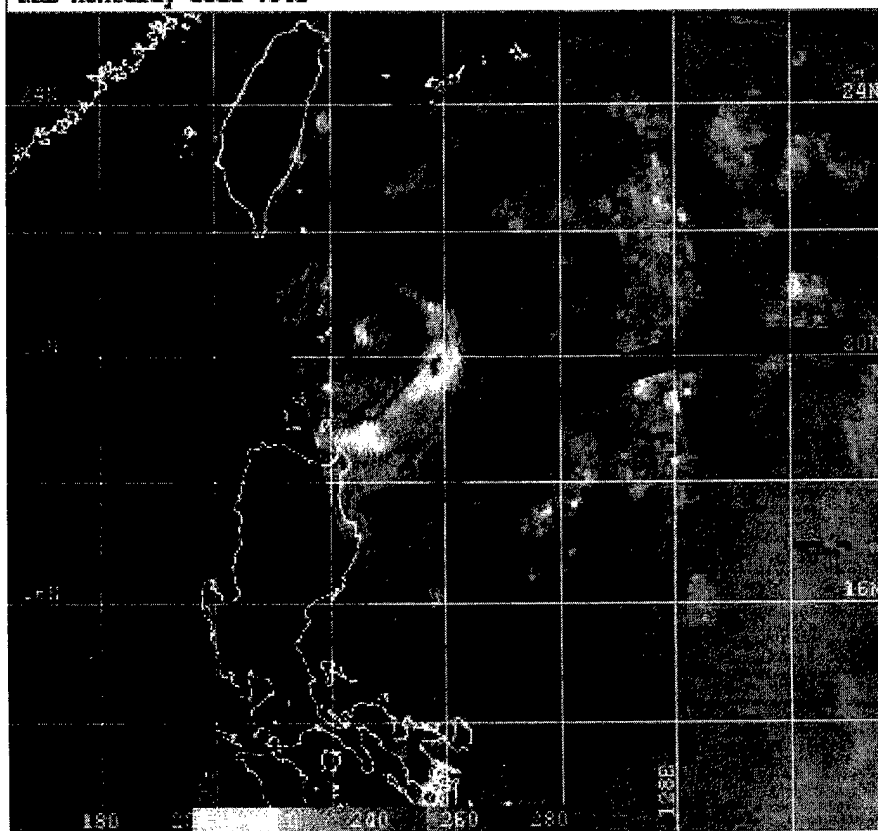
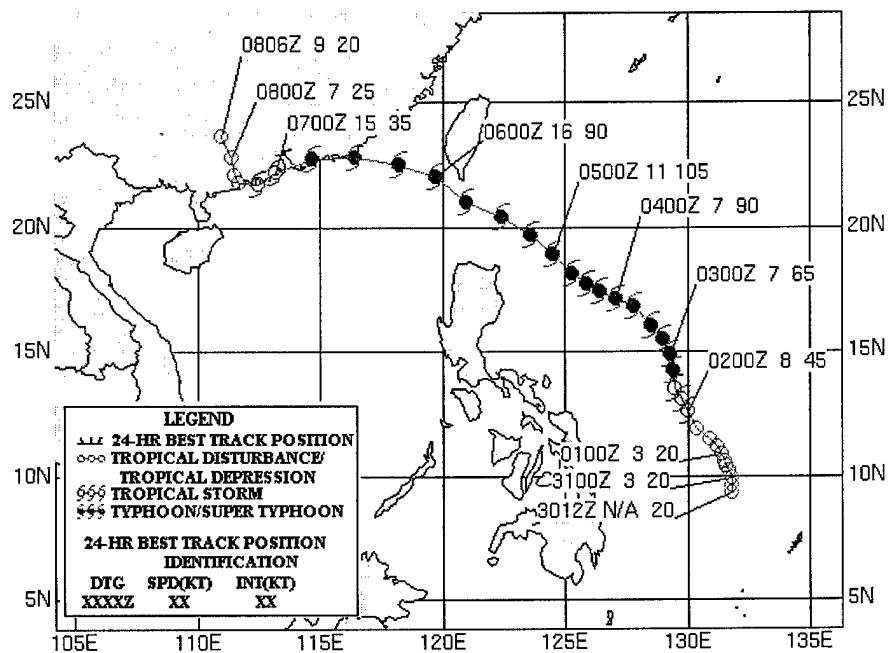


Figure 1-06-2. The convective structure of Typhoon Maggie (06W) is revealed in this 85Ghz Special Sensor Microwave/Imagery pass near its peak intensity (105 kts) on 051016Z June.



## Tropical Depression 07W

Tropical Depression (TD) 07W developed northeast of Guam in mid July. This weak tropical cyclone initially tracked southwestward before turning northwestward toward Japan. The cyclone reached a peak intensity of 30 kt before turning northward and dissipating over water southeast of Honshu.

JTWC first mentioned TD 07W as a suspect area on a 131600Z July Significant Tropical Weather Advisory (ABPW). At 142030Z July, a Tropical Cyclone Formation Alert was issued as the disturbance had gained some strength and organization. The first JTWC warning on TD 07W was issued at 150300Z July for a 25 kt system.

TD 07W formed within a moderate vertical wind shear environment with the subtropical ridge to the east, which would become the primary steering influence. TD 07W intensified to 30 kt 12 hours after the first warning and maintained that intensity for two days. Increased vertical windshear completely exposed the low-level circulation center by 152330Z July, and subsequently TD 07W began to weaken. JTWC issued the 14th and final warning at 180900Z July as the system dissipated southeast of Honshu.

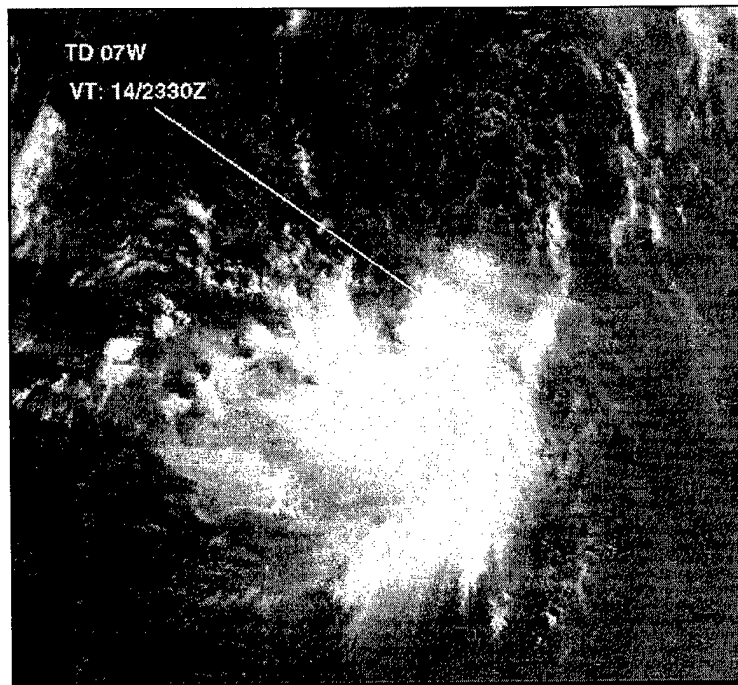


Figure 1-07-1. 142330Z July visible satellite image of TD 07W as it reached warning criteria of 25 kt.

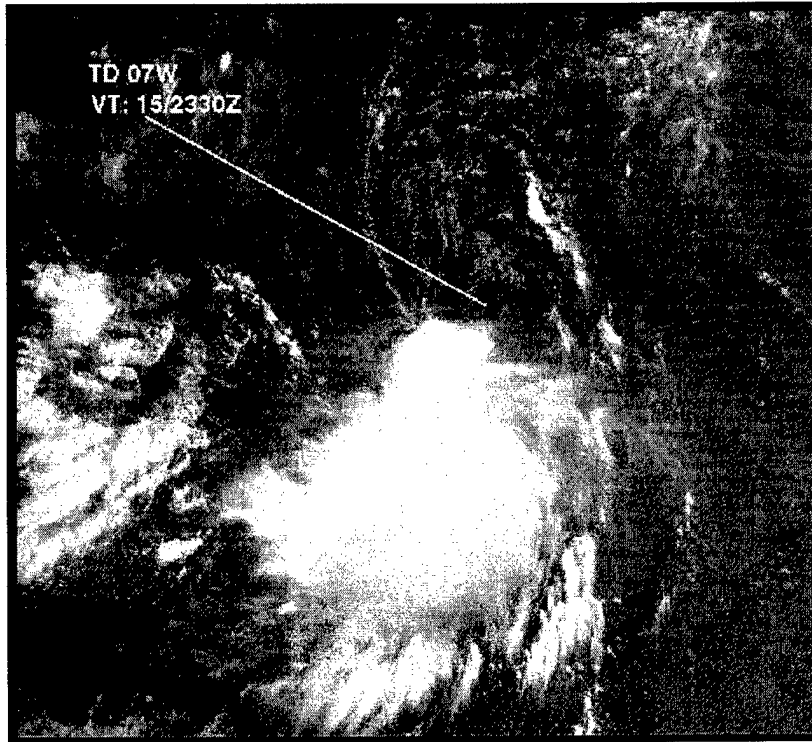
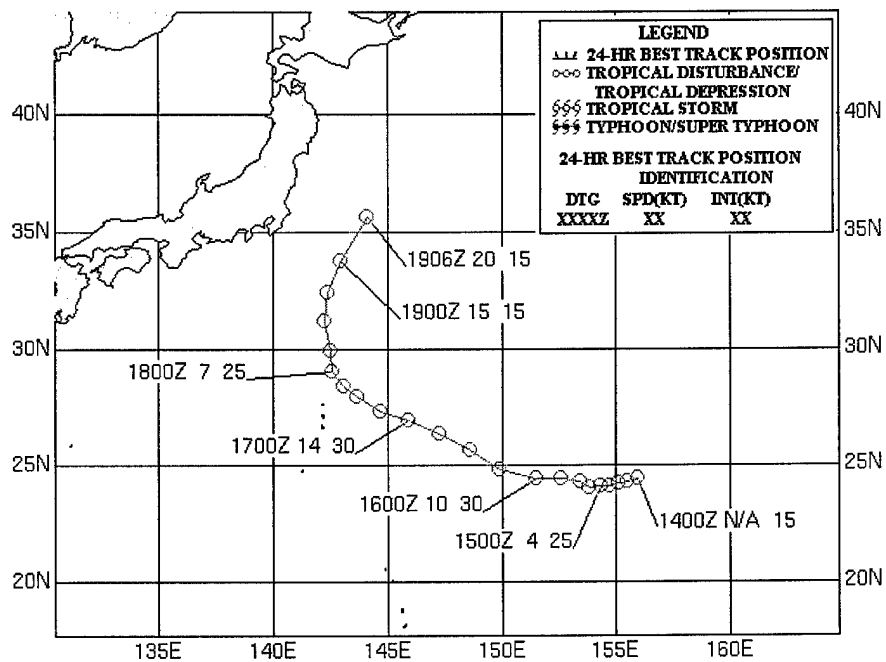


Figure 1-07-2. 152330Z July visible satellite image of TD 07W after vertical wind shear fully exposed the low-level circulation center. Current intensity was 25 kt.





## Tropical Depression 08W

Tropical Depression (TD) 08W developed northeast of Okinawa in mid July and tracked northward into the East China Sea before turning northwestward toward Korea. The cyclone attained a peak intensity of 30 kt before making landfall near Changhung, South Korea at 220900Z July.

JTWC first mentioned TD 08W as a suspect area on the 170600Z July Significant Tropical Weather Advisory (ABPW). By 180730Z July, the suspect area had gained some strength and organization and a Tropical Cyclone Formation Alert (TCFA) was issued and then reissued 24 hours later. Decreased organization and weakening led to a TCFA cancellation by 191730Z July. However, by 210100Z July, the suspect area began reorganizing and a third TCFA was issued. JTWC commenced warning on TD 08W at 210900Z July.

TD 08W formed west of a low-level subtropical ridge, which steered the cyclone north into the East China Sea before recurving and moving northwestward toward the Korean Peninsula. TD 08W made landfall near Changhung, South Korea at 220900Z and began to weaken rapidly. TD 08W experienced extratropical transition within the mid-latitude westerlies over South Korea and subsequently moved into the Sea of Japan, where JTWC issued the sixth and final warning at 221500Z July.

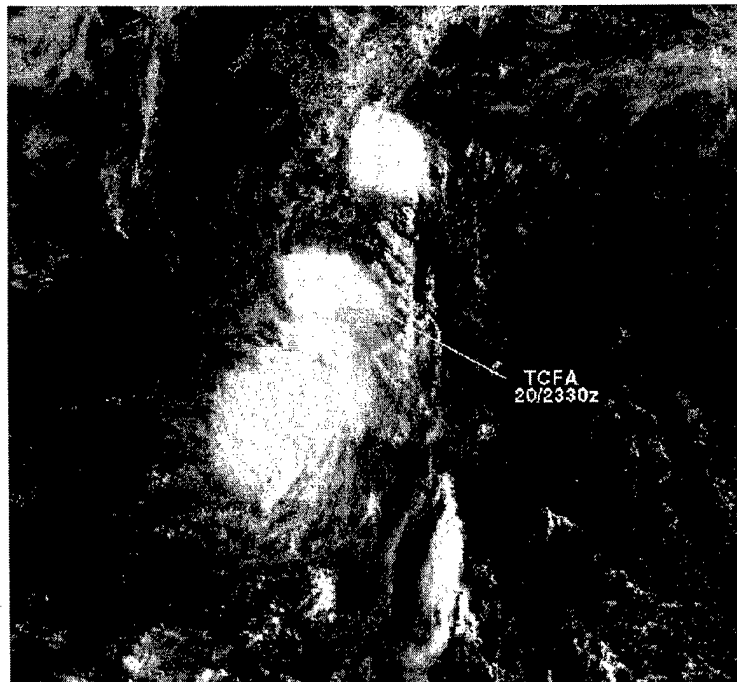


Figure 1-08-1. 202330Z July visible satellite image of the tropical disturbance that would become TD 08W.

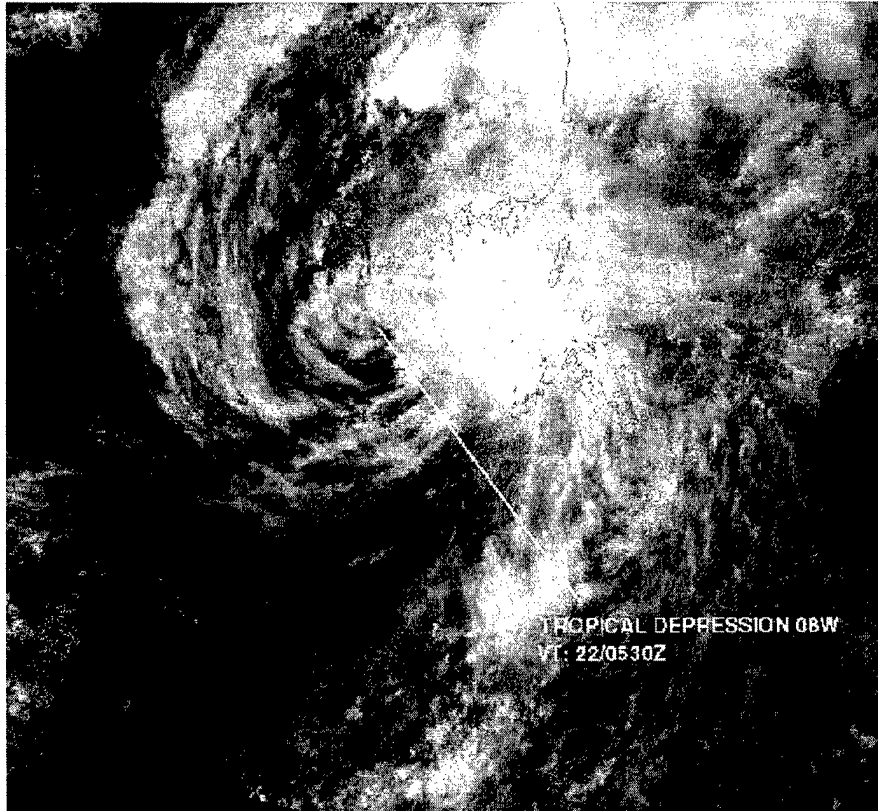
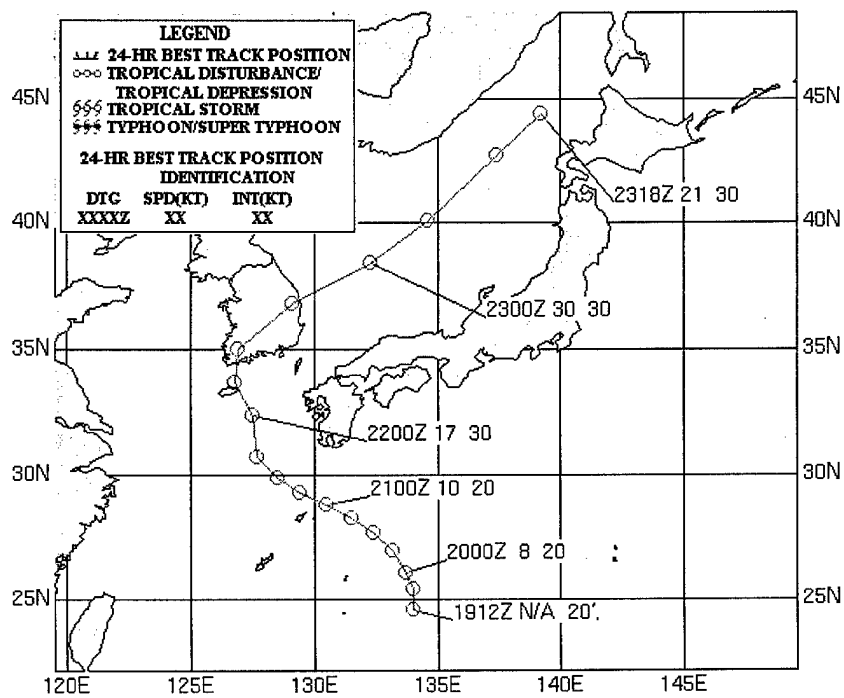


Figure 1-08-2. 220530Z July visible satellite image of TD 08W about 3 hours before making landfall near Changhung, South Korea. The image shows a partially exposed low-level circulation center with the deep convection sheared towards the east.



## Tropical Storm Neil (09W)

The disturbance that became Tropical Storm Neil (09W) began forming in the monsoon trough located in the Philippine Sea, just east of Luzon island, on 23 July. At the same time, within this very active monsoon trough, TD 10W was forming west of Luzon in the South China Sea. TS Neil tracked northeastward before turning more northward onto the Republic of Korea (ROK) on 27 July. TS Neil reached a peak intensity of 40 kt and made landfall in the ROK as a minimal tropical storm (35 kt). TS Neil was the second tropical cyclone to bring heavy rains to the ROK within a week. A Japanese news report stated a ferry was forced aground due to high winds, no injuries were reported.

JTWC first began tracking the tropical disturbance on 230000Z July and mentioned it on the 240600Z July ABPW. As the convection began consolidating, a TCFA was issued on 241730Z July and the first warning was issued on 250900Z July. For the first two days, TD 09W tracked northeastward within the monsoon trough. As it gained latitude and approached Okinawa, Japan, the cyclone turned more northward in response to the subtropical ridge to the east building westward. During the northward turn, TD 09W also intensified to tropical storm intensity.

TS Neil peaked at 40 kt on 26 July and as it approached the Japanese main islands, it took a slightly west of north path and moved inland over the southern Republic of Korea, 18 nm southwest of Suncheon at 270500Z as a minimum tropical storm (35 kt). TS Neil then continued to slowly weaken and move over the Yellow Sea before interacting with a mid-latitude trough. This interaction caused the cyclone to turn northeastward back over the northern portion of the ROK on 28 July, making landfall 20 nm southwest of Seoul at 280600Z as a 20 kt system.

JTWC issued the 13th and final warning at 280900Z July as TD 09W moved inland and dissipated over the Republic of Korea.

As TS Neil moved past the Japanese Island of Kyushu the Associated Press reported a ferry had run aground in Kannoura, Japan due to high winds from the storm. The US Forces Korea (USFK) Theater Forecast Unit received reports of gusts to 50 kt with 5 inches of rain on Cheju Island, ROK and southern areas of the ROK received 2-4 inches of rain with max gusts of 42 kt. The Korea Times, 28 July, reported 200mm of rainfall on Cheju Island on 27 July. They also reported a fishing boat capsized after colliding with another vessel in rough seas south of Wando Island. The crew of eight on the fishing boat perished. The JMA reported damage from floods and strong wind gusts.

SATELLITE: f14 1999 07 26 0024Z 85 GHZ H (Brightness Temperature)  
 WARNING: NONAME (09W) 990725 1800 26.4N 128.3E  
 NRL Monterey Code 7541

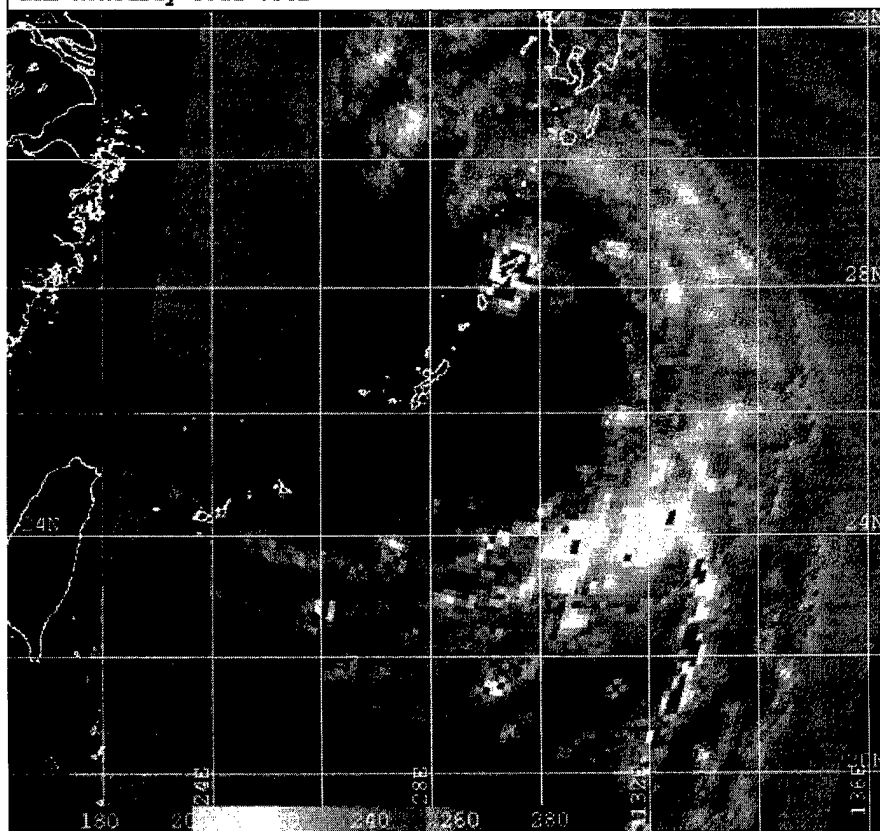


Figure 1-09-1. 260024Z July Special Sensor Microwave Imager (SSM/I) pass of TS Neil (09W). The center was located just west of Amamami O Shima, Japan. TS Neil was at 35 kt intensity and peaked at 40 kt six hours later.

SATELLITE: f14 1999 07 26 0024Z 85 GHZ H (Brightness Temperature)  
 WARNING: NONAME (09W) 990725 1800 26.4N 128.3E  
 NRL Monterey Code 7541

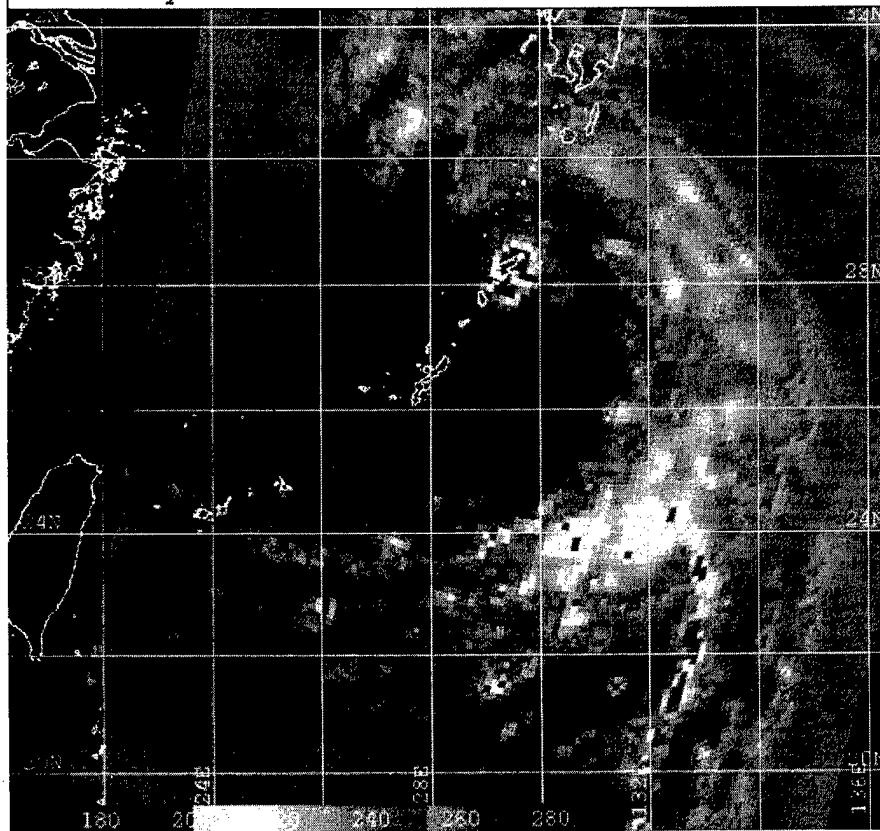


Figure 1-09-1. 260024Z July Special Sensor Microwave Imager (SSM/I) pass of TS Neil (09W). The center was located just west of Amamami O Shima, Japan. TS Neil was at 35 kt intensity and peaked at 40 kt six hours later.

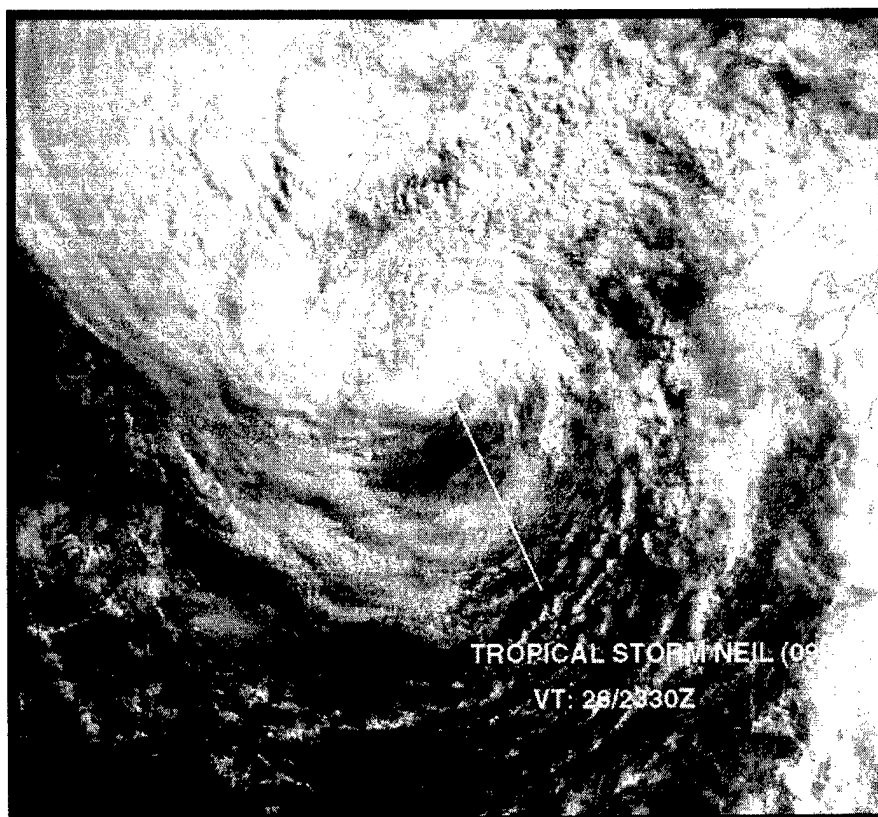


Figure 1-09-2. 262330ZZ July GMS-5 visible imagery of TS Neil (09W) as a 35 kt storm just east of Cheju Island, ROK. TS Neil made landfall six hours later 20 nm southwest of Sancheon, ROK.



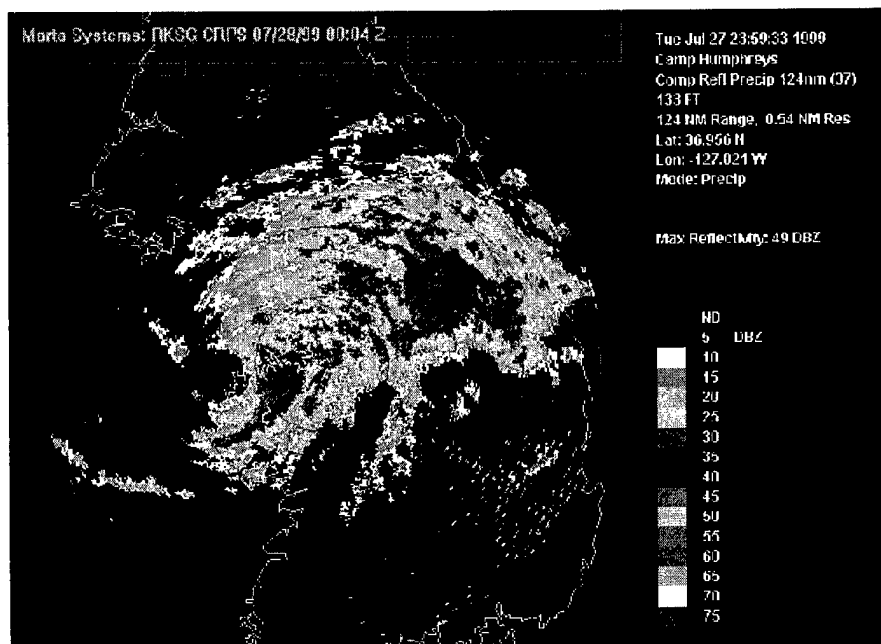
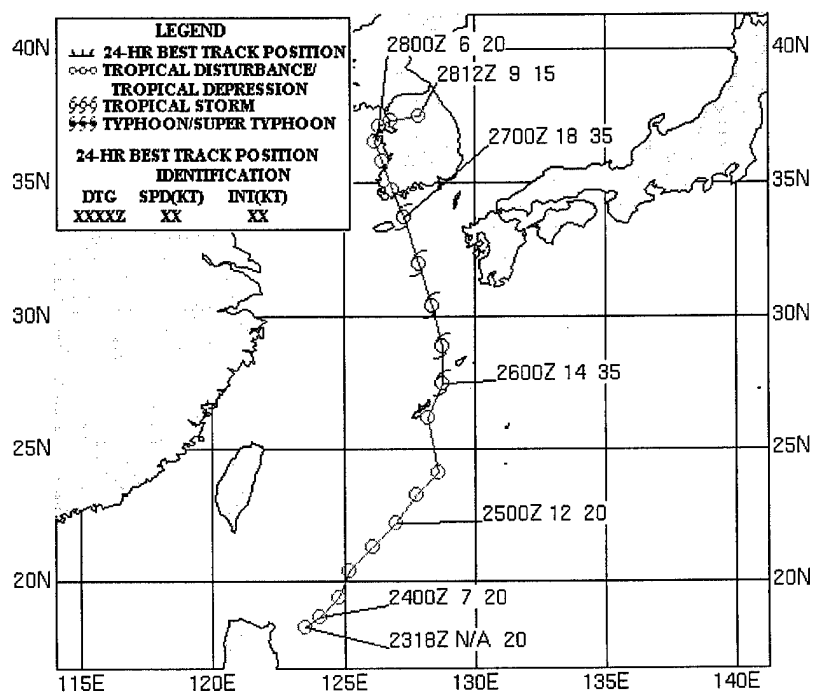


Figure 1-09-3. 272359Z July Camp Humphreys WSR-88D reflectivity image of TS Neil. TS Neil was downgraded to a 20 kt system shortly hereafter. The remnants of TS Neil made landfall 20 nm southwest of Seoul, ROK six hours later (280600Z).



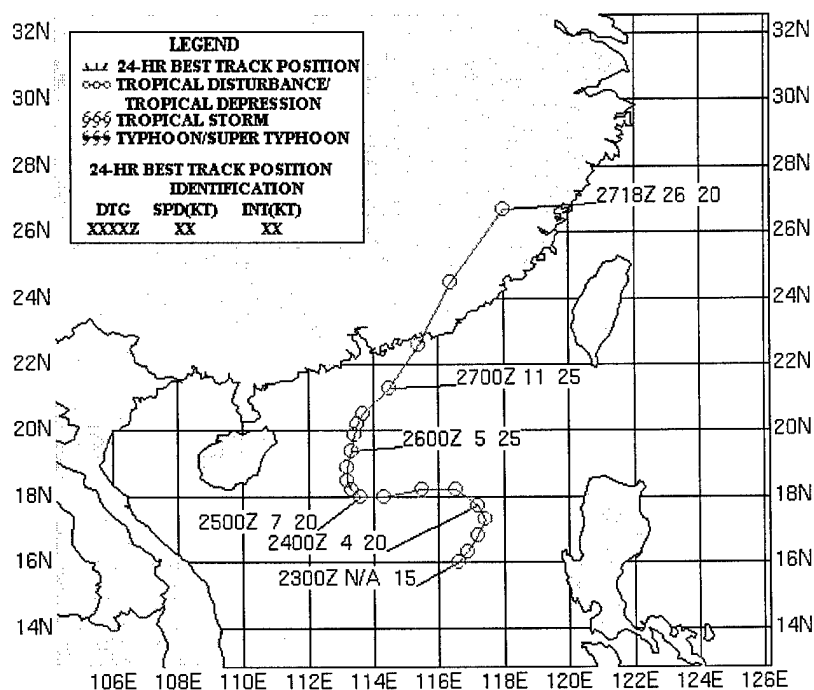
## Tropical Depression 10W

Tropical Depression (TD) 10W began forming in the South China Sea, west of Luzon, Philippines on 23 July, reached tropical depression intensity on 251800Z July and remained a minimum TD as it meandered toward the Chinese coast. TD 10W made landfall near Shanwei, China on 270600Z July.

JTWC first began tracking the tropical disturbance on 230000Z July and mentioned it on the 230900Z July ABPW located west of Luzon in the South China Sea. TD 10W developed within a very active monsoon trough oriented from the South China Sea across Luzon to a disturbance that was to become TS Neil (09W), in the Philippine Sea. A TCFA was issued on 261800Z with the first warning issued immediately following it at 262100Z July.

The cyclone remained a very weak TD as it tracked north-northeastward under the steering flow of the subtropical ridge to the east. Synoptic data indicated a broad circulation, with a barely discernable low level circulation center on satellite imagery. TD 10W made landfall near Shanwei, China on 270600Z as a minimum TD.

JTWC issued the third and final warning at 270900Z July as TD 10W moved inland and dissipated. Post analysis indicated TD 10W actually reached 25 kt intensity on 251800Z, hence best track intensities were increased from 20 kt prior to the first warning.



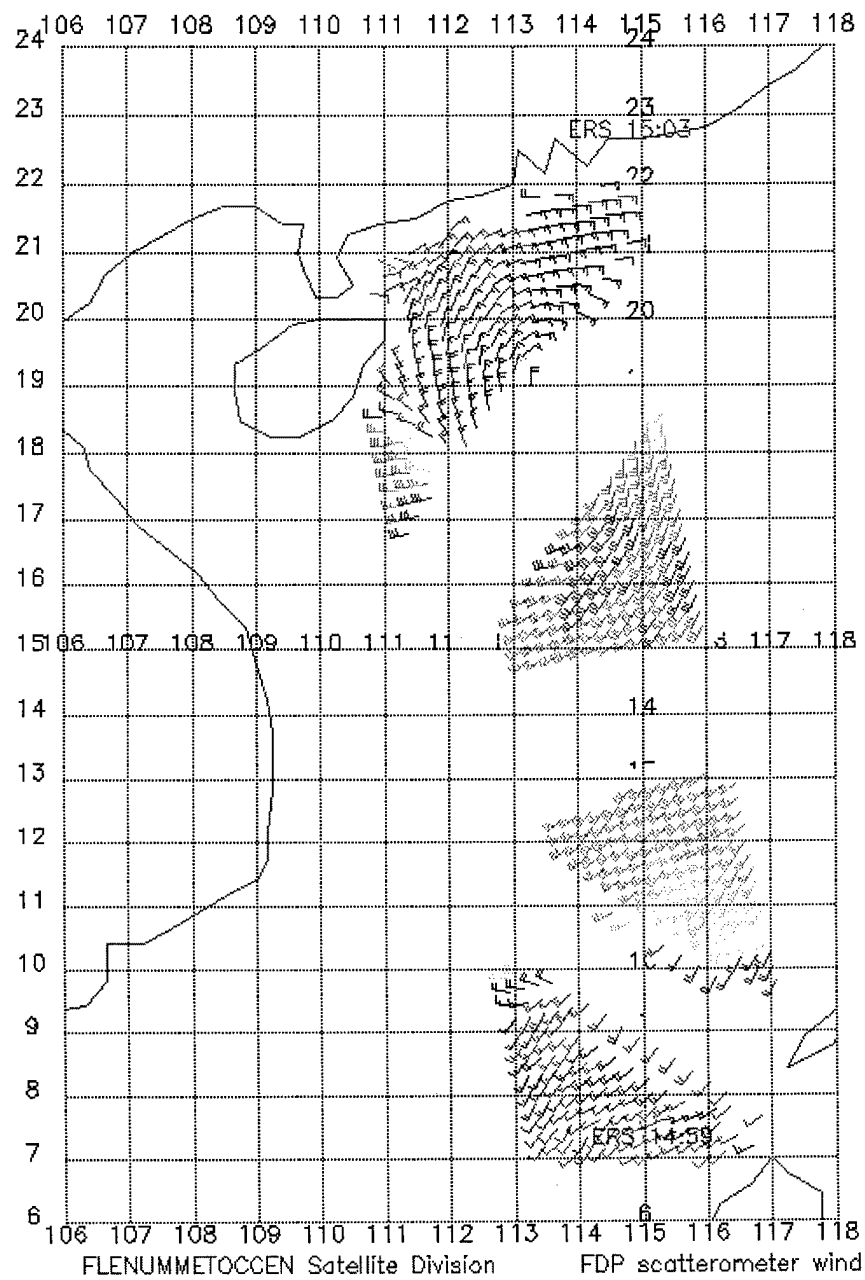


Figure 1-10-1. 251503Z July ERS-2 scatterometer pass. This pass indicated winds were greater than Dvorak analysis yielded. Hence, post analysis increased winds of the best track.

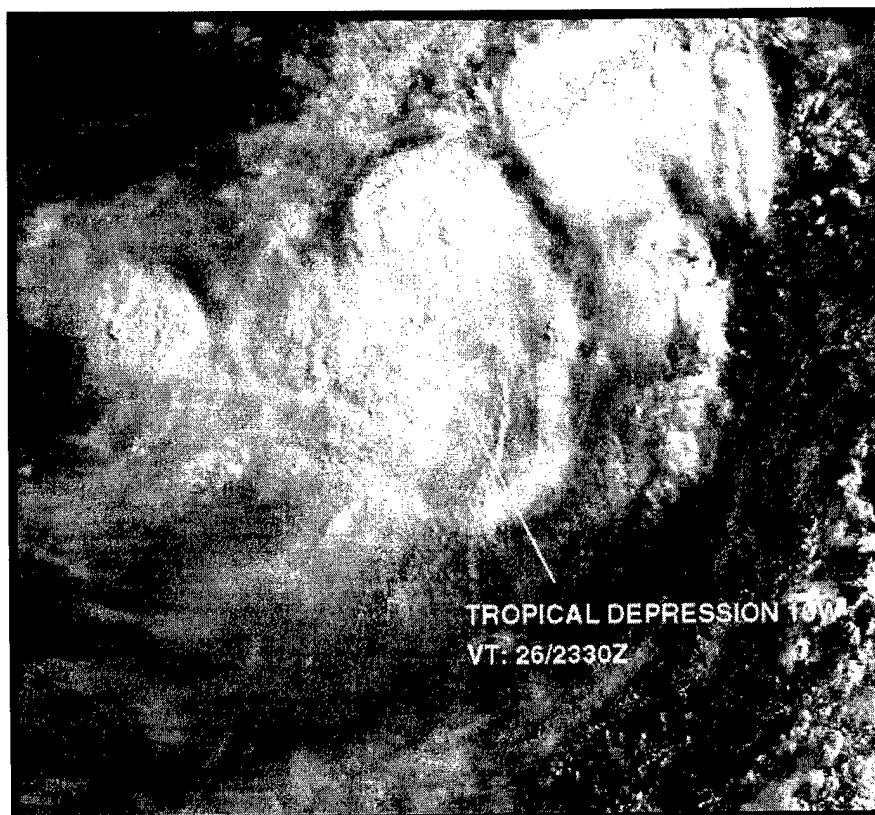


Figure 1-10-2. 262330Z July GMS-5 visible image. TD 10W was a 25 kt TD as it approached the Chinese coast. TD 10W made landfall about seven hours later.

## Typhoon Olga (11W)

Typhoon (TY) Olga (11W) developed in the Philippine Sea, just west of Yap, in late July. TY Olga developed in the eastern end of a well-defined monsoon trough and tracked north-northwestward around a strong subtropical high to its northeast. TY Olga gradually intensified and peaked at 80 kt just northwest of Okinawa. TY Olga made landfall on Okinawa, the Republic of South Korea (ROK), and finally North Korea during its nine day lifecycle. Minimum damage was received on Okinawa, but torrential rains in South and North Korea led to landslides and fatalities. These heavy rains came only a few days after heavy rains associated with a frontal boundary moved through the area.

JTWC first began tracking the tropical disturbance on 261800Z July and included the disturbance on the 270600Z July ABPW. As the convection became better organized a TCFA was issued at 280230Z July. Over the next 24 hours, the convection continued to consolidate and JTWC issued the first warning at 290300Z July.

TY Olga (11W) slowly intensified and reached 75 kt intensity as it approached Okinawa, Japan. The ragged eye (Figure 1-11-1) began to weaken just prior to landfall over Ourawan Bay, Okinawa, about 10 nm east of Kadena Air Base. Figure 1-11-2 shows the deep convection was limited to the northeast quadrant as TY Olga made landfall at 011200Z August. The peak wind gust on Okinawa associated with landfall was at Kadena Air Base (011324Z August - 43 kt). As TY Olga moved off Okinawa, it continued to track north-northwestward and re-intensified to its peak of 80 kt. Additionally, a strong spiral band developed and moved over Okinawa and other southern islands (Figure 1-11-3 and 4). Okinoerabu (RJKB) reported 15038G53kt (10 minute mean) and Kumejima (ROKJ) reported 23028G38kt on 020600Z December associated with the spiral band passage.

As TY Olga (11W) gained latitude, a mid-latitude trough began digging into the Yellow Sea from China transitioning the steering flow to a more "poleward" pattern. TY Olga began a more northward track and accelerated. TY Olga passed just west of Cheju Island, ROK and along the west coast of the ROK making landfall briefly over the T'aeon Peninsula, about 40 nm southwest of Suweon, ROK, before making its final landfall in North Korea at 031400Z August as a strong tropical storm (55 kt). As TY Olga began interacting with the mid-latitude trough, it took on extratropical characteristics and began weakening.

JTWC issued the 24th and final warning on 032100Z August as the system weakened and became extratropical over North Korea.

Reuters reported torrential rains and landslides led to 64 fatalities in ROK and North Korea. US and ROK airbases in ROK also reported damage to buildings with only minor injuries as winds gusted to 52 kt at Seoul AB and 48 kt at Kunsan AB.

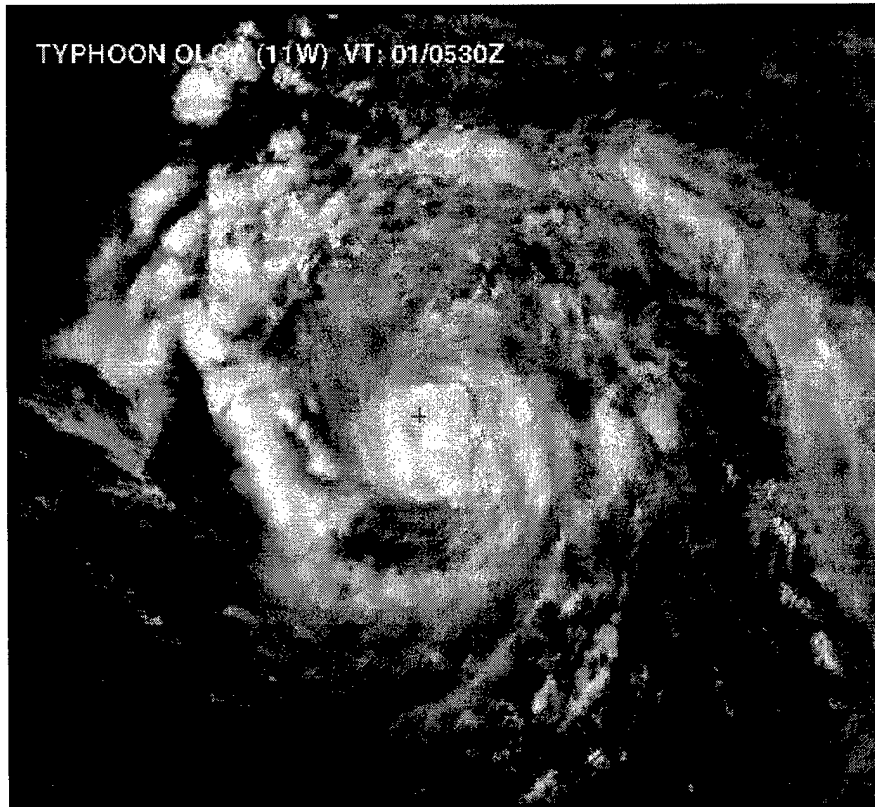


Figure 1-11-1. 010530Z August GMS-5 visible image of TY Olga (11W) approaching Okinawa, Japan. TY Olga (11W) was at 75 kt and beginning to show signs of weakening. As it moved over Okinawa, it was at minimum TY intensity (65 kt).

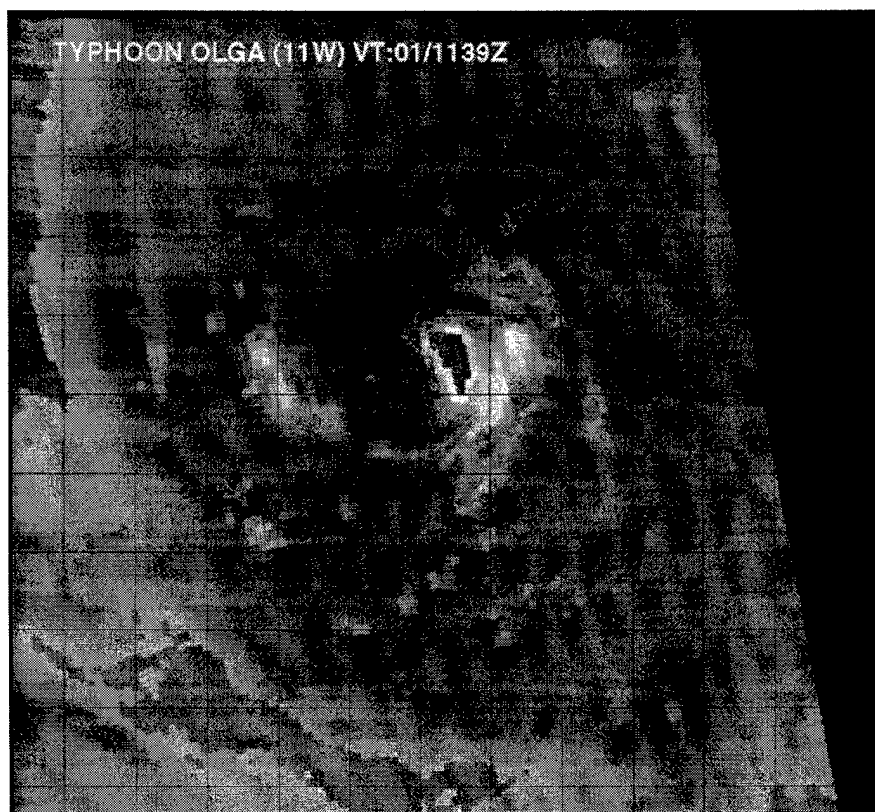


Figure 1-11-2. 011139ZZ August SSM/I pass of TY Olga (11W) as it moved over Okinawa, Japan. TY Olga (11W) was at 65 kt with deep convection limited to the northeastern quadrant.





Figure 1-11-3. 012230Z August GMS-5 visible image of TY Olga (11W) northwest of Okinawa, Japan. TY Olga (11W) was at 75 kt with a strong spiral band on the eastern half. This band actually brought stronger wind gusts and heavier rains to the southern Japanese islands than the actual passage of the typhoon. TY Olga (11W) began intensifying and peaked at 80 kt 12 hours later.

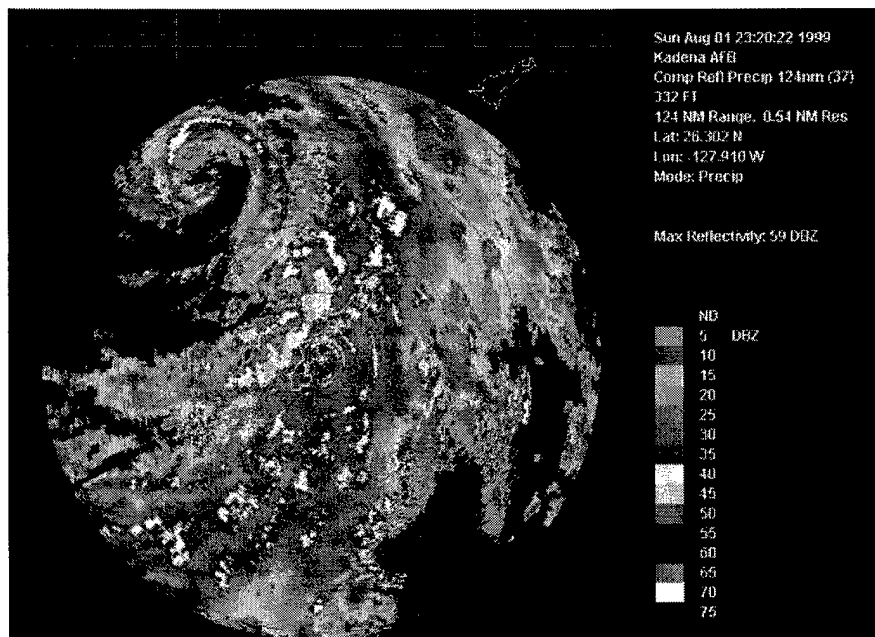


Figure 1-11-4. 012320Z August WSRD-88 NEXRAD radar image from Kadena AB, Japan. Image shows the band now moving offshore of Okinawa and a well-defined TY Olga (11W) to the northwest. TY Olga (11W) was at 70 kt intensity and continuing to intensify.

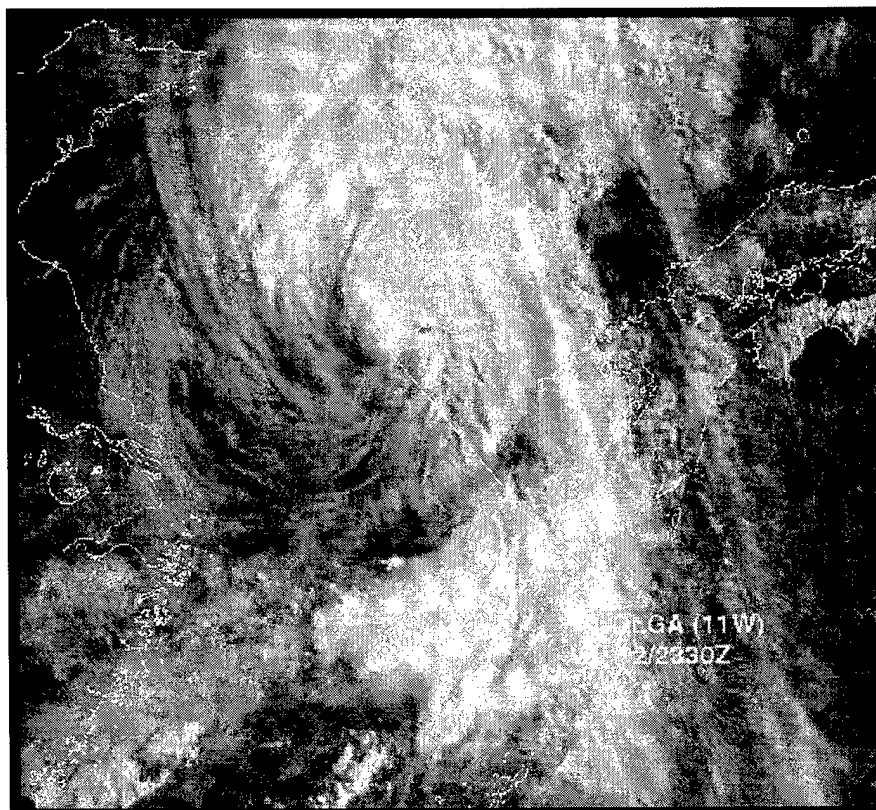
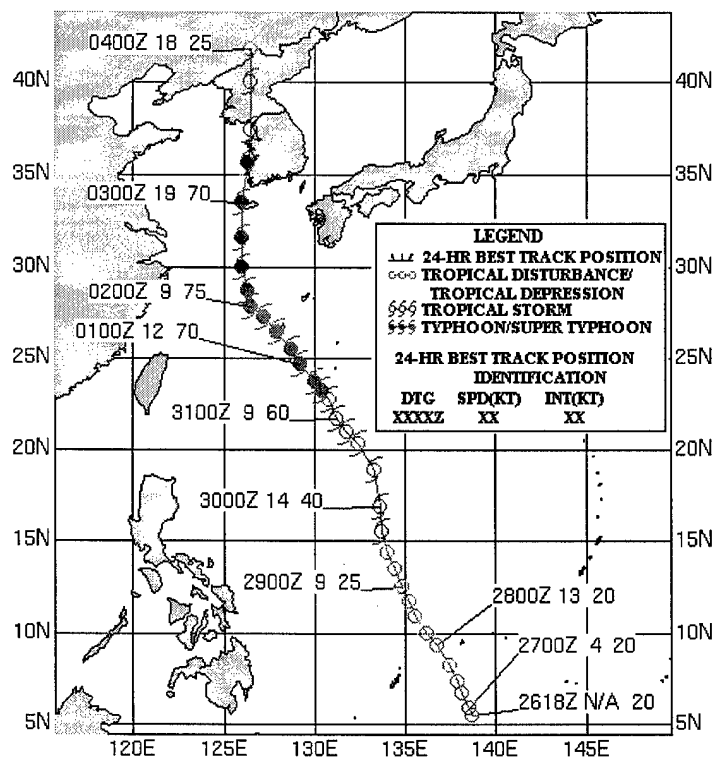


Figure 1-11-5. 022330Z August GMS-5 visible image of TY Olga (11W) just northwest of Cheju Island, ROK. TY Olga (11W) was at 75 kt intensity.



## Tropical Storm Paul (12W)

Tropical Storm Paul (12W) formed in early August in the southeast quadrant of a large monsoon gyre centered southeast of Okinawa and attained a maximum intensity of 50 kt on 050600Z August. This cyclone was unique in that it developed from a monsoon gyre and then merged into the gyre. During the merger period, TS Paul remained quasi-stationary for 12 hours and after the merger moved toward the Yellow Sea where it dissipated on 08 August.

JTWC issued a Tropical Cyclone Formation Alert on 020230Z August for a low-level circulation embedded in the deep convection associated with the monsoon gyre. As the circulation continued to intensify, JTWC issued the first warning on TD 12W at 031500Z August with maximum sustained winds of 25 kt.

TD 12W initially moved northwestward along the eastern periphery of the gyre (see Figure 1-12-1) and soon after reaching tropical storm intensity at 041800Z August turned westward as the cyclone merged with the monsoon gyre east of Okinawa (see Figure 1-12-2). It was during this merger period that TS Paul attained a maximum intensity of 50 kt at 050600Z August.

A review of past WESTPAC cyclones associated with monsoon gyres indicate that mergers rarely occur. The data indicates that it is much more common for a tropical cyclone to move either along the northern periphery of the gyre northeastward under the steering influence of a subtropical ridge located to the southeast, or continue westward north of the monsoon gyre. TS Paul took the least common scenario, merging with the gyre.

Another complexity noted with tropical cyclones that merge with monsoon gyres is that some of the tropical cyclones expand areally after merger and some do not. TS Paul (12W) did not expand in area after merger whereas a 1991 cyclone, TS Gladys (14W), merged with a monsoon gyre and evolved into a large tropical cyclone. The only differences noted in the synoptic and meteorological satellite data between TS Paul (1999, 12W) and TS Gladys (1991, 14W) was that TS Paul (12W) had much less associated deep convection than TS Gladys (14W). In the case of TS Gladys (14W), abundant deep convection was evident throughout the area and literally wrapped around the huge gyre. For TS Paul (12W), there was little associated convection and a large TUTT cell located over the cyclone. Thus, it appears that the TUTT may have influenced the TS Paul (12W)/monsoon gyre merger and the nonexpansion of the cyclone.

After the merger, TS Paul weakened to a tropical depression (see Figure 1-12-3) then initially moved northeastward. By 060600Z August, TS Paul had moved under the steering influence of the subtropical ridge to its north and began to track northwestward and then westward at 11 to 15 kt as a 25 kt system.

On 061800Z August TS Paul skimmed the southwest coast of Kyushu as a 25 kt system and the Japan Meteorological Agency reported that associated rainfall caused damage from landslides and floods in western Japan. TS Paul subsequently dissipated over water in the Yellow Sea and JTWC issued the 19th and final warning at 080300Z August.

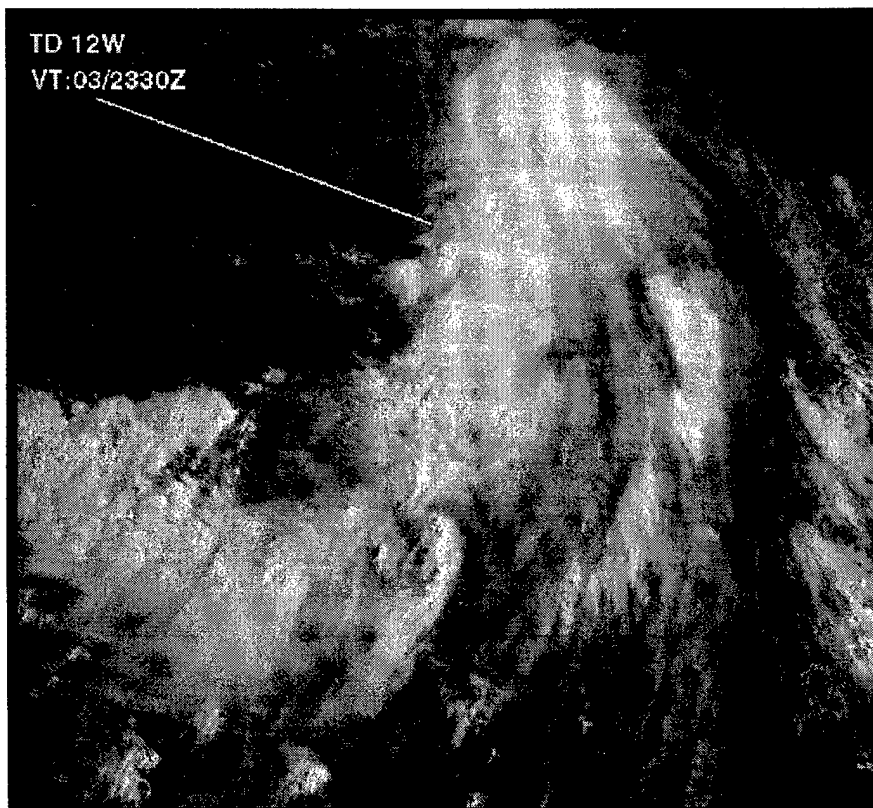


Figure 1-12-1. A visible satellite image showing TD 12W embedded within the southeast quadrant of a monsoon gyre centered southeast of Okinawa.

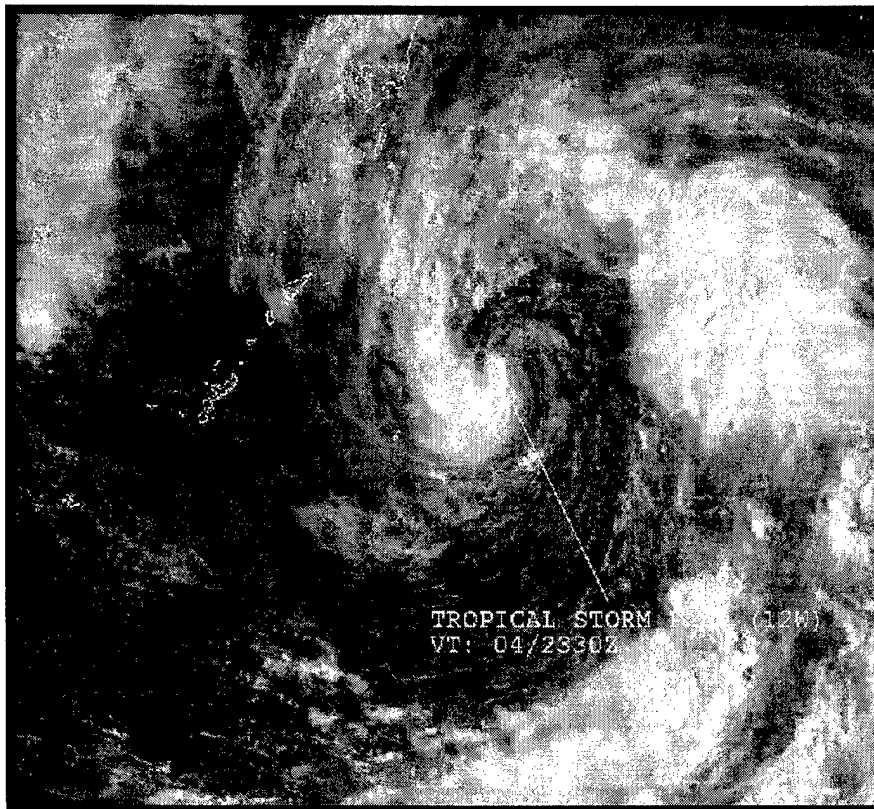


Figure 1-12-2. A visible satellite image of TS Paul (12W) just after it merged with the monsoon gyre east of Okinawa.

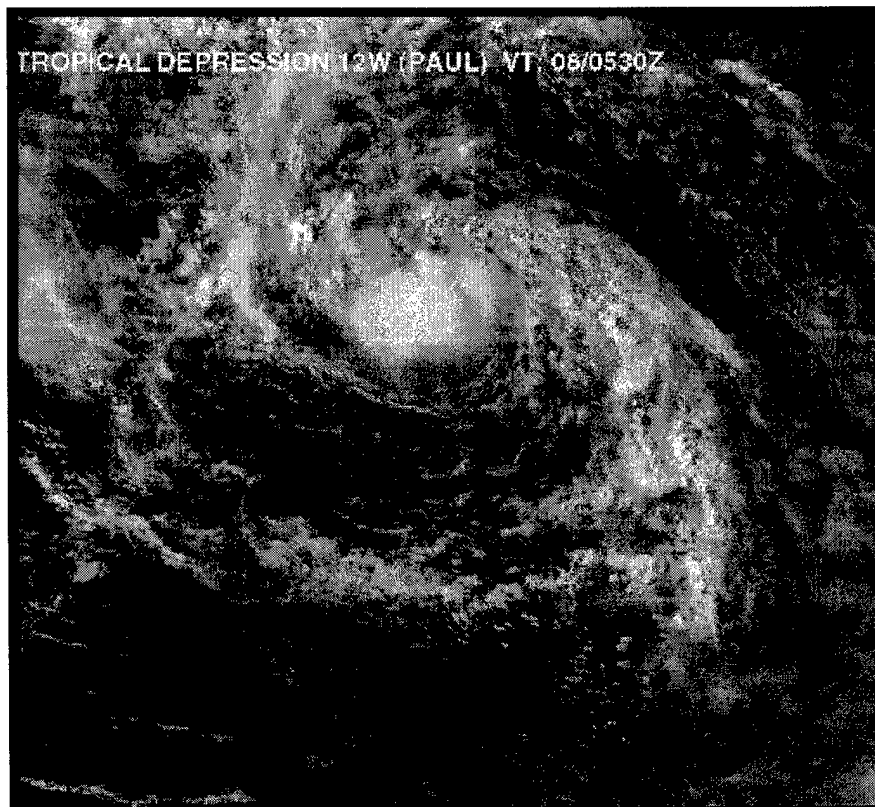
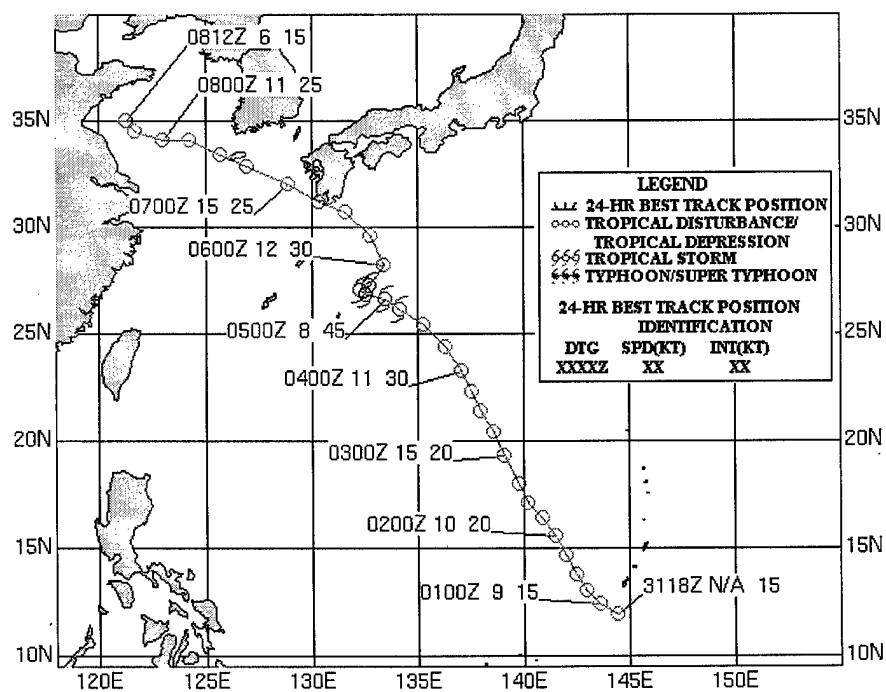


Figure 1-12-3. A visible satellite image of TD 12W (Paul) six hours after it merged with the monsoon gyre. The monsoon gyre itself collapsed around TD 12W (Paul) and together they became a large depression which moved off to the northwest.



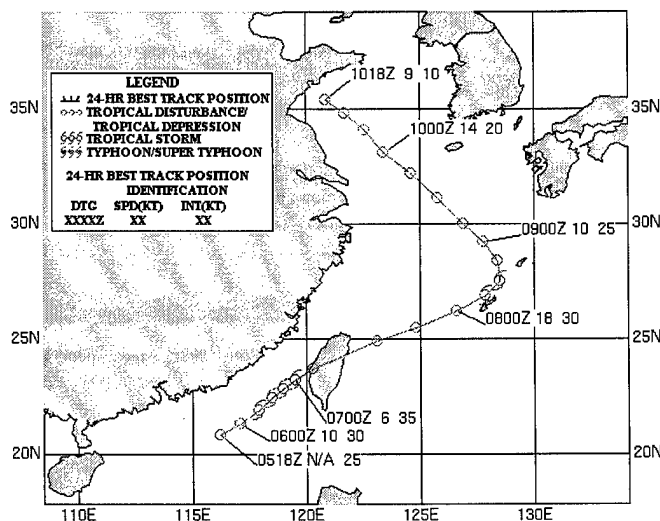


## Tropical Storm Rachel (13W)

Tropical Storm (TS) Rachel (13W), the 13th 1999 Northwest Pacific Ocean tropical cyclone warned on by JTWC, developed in the South China Sea, intensified to a tropical storm, moved northeastward over Taiwan, and dissipated after only 36 hours later. This cyclone then regenerated as it moved into the East China Sea toward Okinawa and then turned northwestward, to dissipate over the Yellow Sea 5 days after initial development.

TS Rachel (13W) formed approximately 140 nm southeast of Hong Kong on 5 August. JTWC issued the first warning on TS Rachel at 060900Z August. By 061200Z August, the cyclone had reached a maximum intensity of 35 kt. The system weakened significantly as it moved over Taiwan, then re-intensified again to a maximum intensity of 35 kt by 080600Z August. Subsequently, cooler sea surface temperatures, and increasing vertical wind shear caused TS Rachel to dissipate over the Yellow Sea at 101800Z August.

TS Rachel (13W) developed in the monsoon trough just off the coast of China. The suspect area which eventually became TS Rachel was first mentioned on the 040600Z August Significant Tropical Weather Advisory (ABPW) with poor potential for development. After 2 days, a Tropical Cyclone Formation Alert (TCFA) was issued for the area. At 060900Z the first warning was issued, as scatterometry data indicated 30 kt winds associated with the tropical cyclone. TS Rachel tracked northeastward over Taiwan, where it dissipated over the Chungyang Mountain range. JTWC issued a final warning on the system at 070900Z August. JTWC subsequently regenerated the cyclone as it moved into the East China Sea and tracked toward Okinawa at 17 kt. TS Rachel (13W) re-intensified to 35 kt as it passed near Okinawa, and turned to the northwest. TS Rachel then moved into cooler waters and increasing vertical wind shear, causing the cyclone to rapidly weaken. JTWC issued the 14th and final warning at 092100Z August.



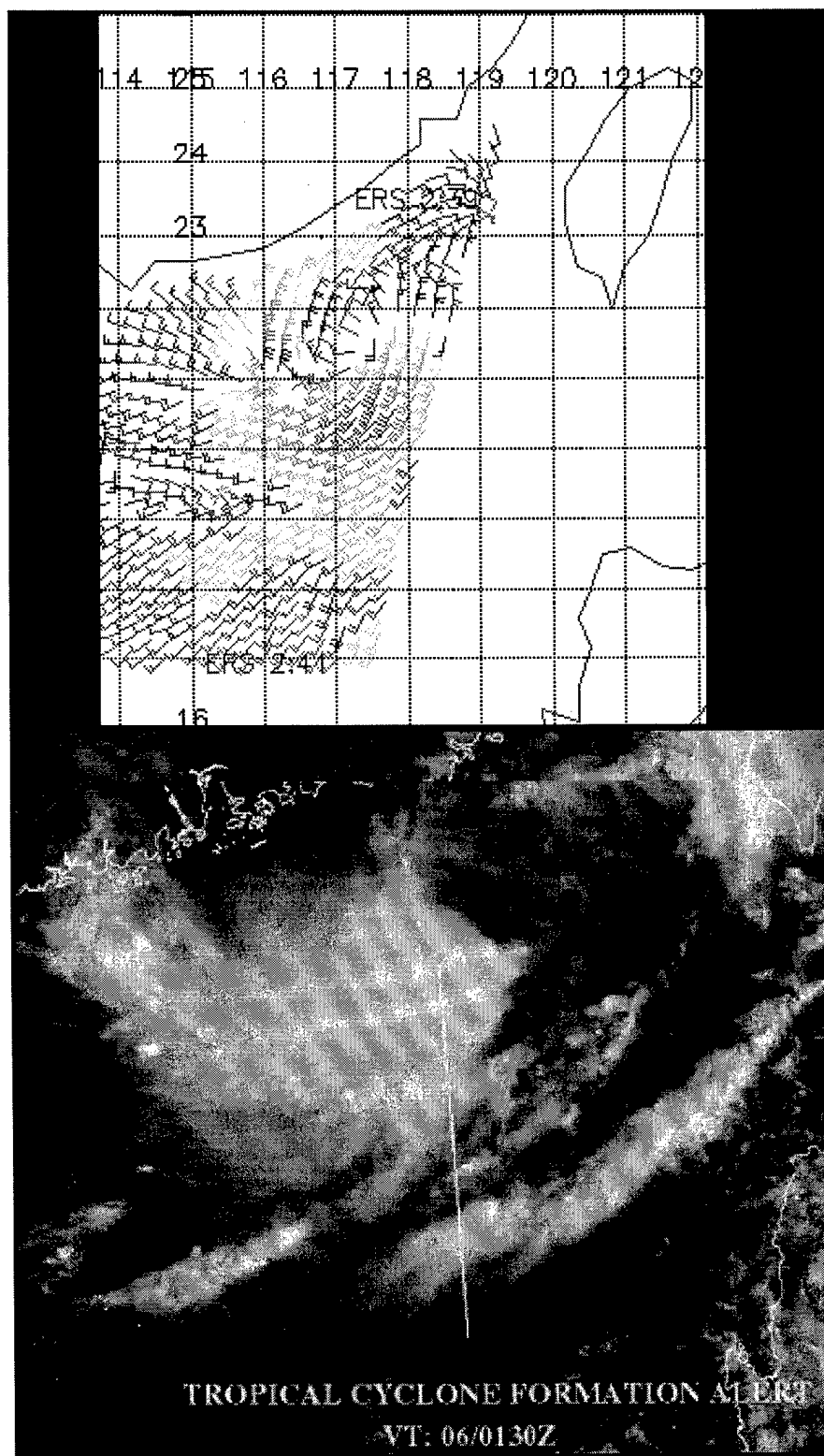
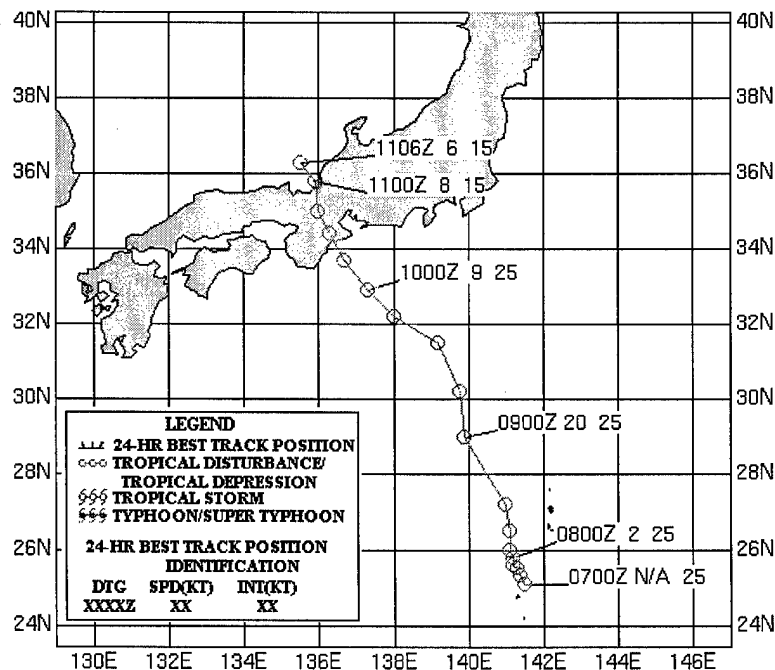


Figure 1-13-1. 060240Z August scatterometry pass, and 060130Z August visible imagery of Tropical Depression 13W which later developed into TS Rachel (13W). Satellite analysis indicated 20 to 25 kt (Dvorak T1.0) through 061025Z. The scatterometry pass however, indicates 30 to 35 kt winds already at 060240Z. The ERS-2 scatterometer has allowed for more accurate analysis of tropical cyclones. This capability will be further exploited as QuickScatt becomes operational.

# Tropical Depression 14W

Tropical Depression (TD) 14W developed 65 nm north of Iwo Jima. It tracked northwest and made landfall near Owase, Japan around 101000Z August, while maintaining a 25 kt intensity.

JTWC issued a Tropical Cyclone Formation Alert at 070230Z August based on Special Sensor Microwave Imager (SSM/I) data which depicted an exposed low-level circulation center with associated convection displaced about 40 nm to the northeast (Figure 1-14-1). The first warning for TD 14W was issued at 082100Z August as a 25 kt cyclone. TD 14W initially moved northward at 5 to 7 kt under the steering influence of the subtropical ridge over northern Japan. TD 14W then turned northwestward around 091200Z August and increased in speed as the subtropical ridge began building over Honshu. TD 14W remained at 25 kt as it made landfall 25 nm northeast of Owase, Japan (Figure 1-14-2) at 101000Z August. TD 14W then began to weaken and moved northward dissipating just north of Honshu on 11 August. JTWC issued the eighth and final warning at 101500Z August.



SATELLITE: f13 1999 08 08 2036Z 85 GHZ H (Brightness Temperature)  
WARNING: NONAME (14W) 990808 1800 27.0N 141.1E  
NRL Monterey Code 7541

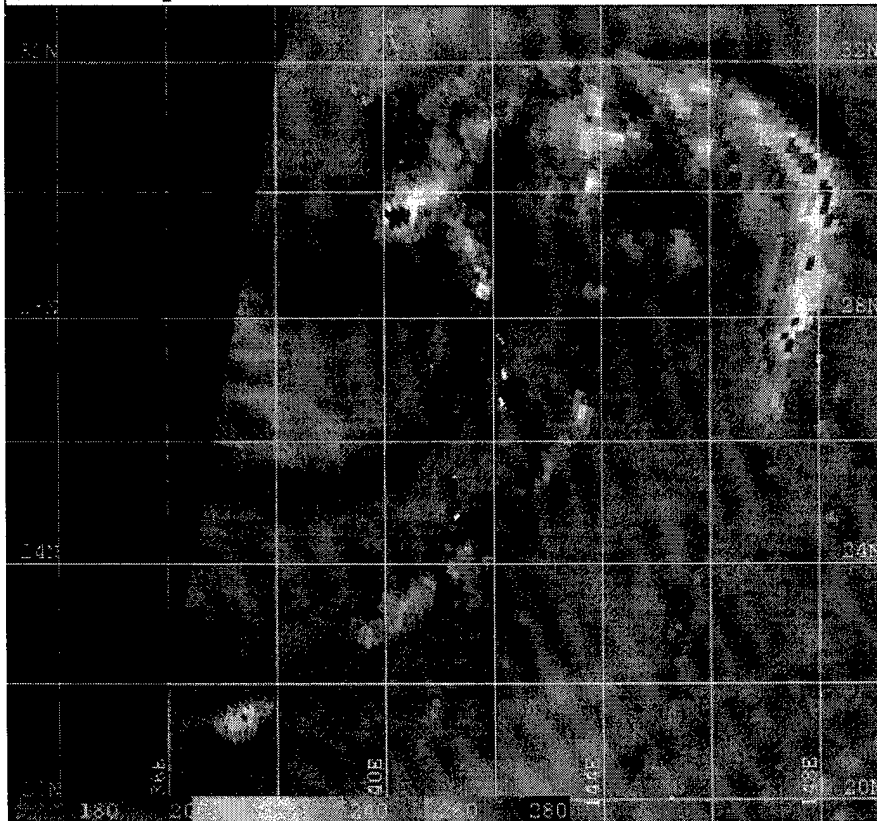


Figure 1-14-1. 082036Z August SSM/I pass reveals a fully exposed low-level circulation center positioned southwest of the associated convection. TD 14W was at 25 kt intensity.

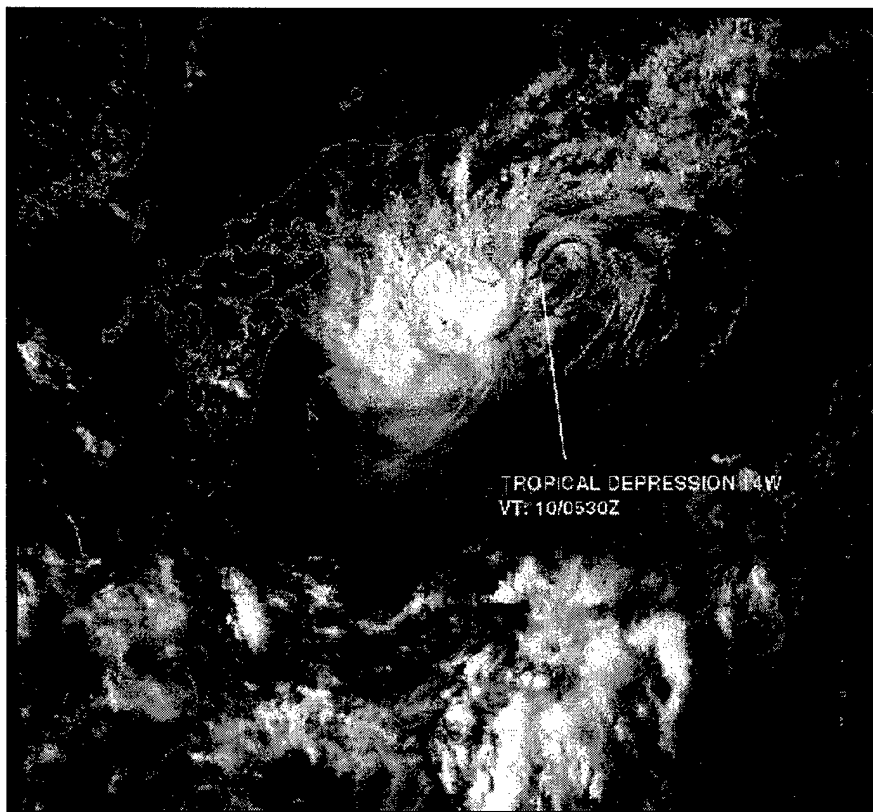


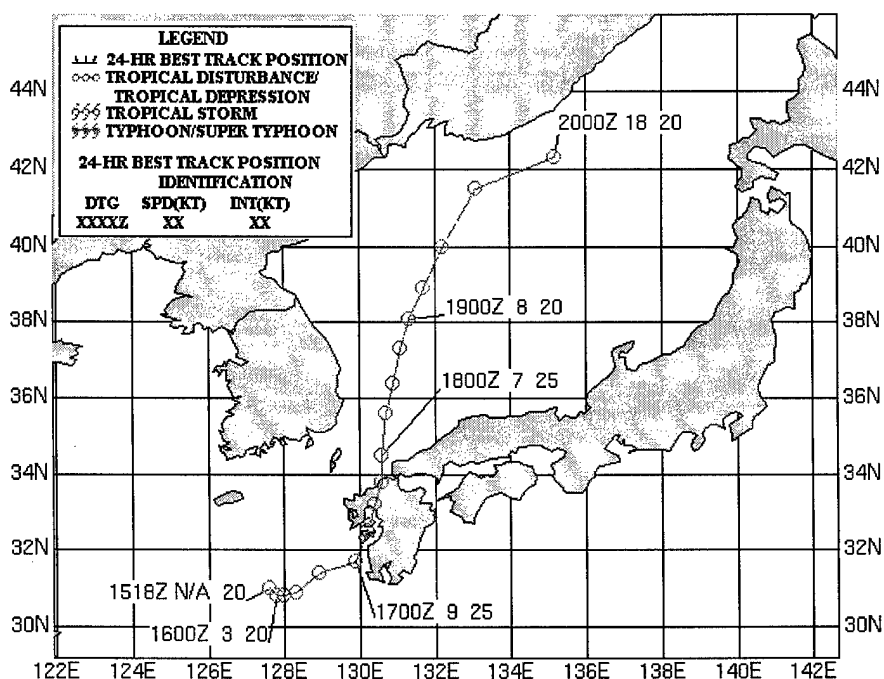
Figure 1-14-2. 100530Z August visible satellite imagery depicted a fully exposed low-level circulation center tracking over the coast of Honshu. TD 14W was at 25 kt intensity.

## Tropical Depression 15W

Tropical Depression (TD) 15W developed in the East China Sea during mid August and initially drifted eastward toward Kyushu, then moved northeastward over Kyushu and into the Sea of Japan. The disturbance reached a peak intensity of 25 kt prior to and after landfall over Kyushu. TD 15W then dissipated over the Sea of Japan.

JTWC first mentioned TD 15W as a suspect area on the 150600Z August Significant Tropical Weather Advisory (ABPW). By 161400Z August, this suspect area had intensified and become better organized. The first warning was issued at 161500Z August. TD 15W was relocated further east on the fourth warning, positioning the disturbance approximately 24 nm from the coast of Kyushu.

TD 15W formed north of the subtropical ridge in the East China Sea with the mid-latitude westerlies as the dominant steering influence. TD 15W initially drifted east toward southwestern Kyushu, making landfall near Ushibuka at 170300Z August. TD 15W then moved northeastward over Kyushu and into the Sea of Japan. TD 15W weakened and dissipated over the Sea of Japan. JTWC issued the 9th and final warning at 180900Z August.



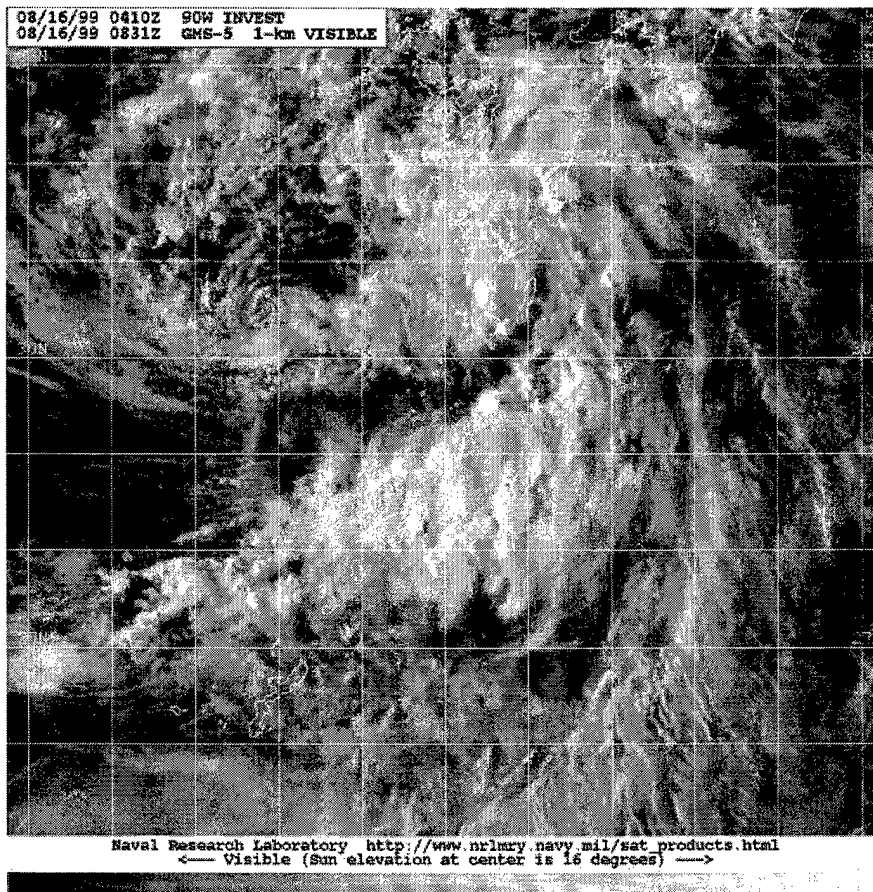


Figure 1-15-1. 160831Z August GMS-5 visible image of TD 15W shortly after the first warning. TD 15W was a small exposed low level circulation at 25 kt intensity.



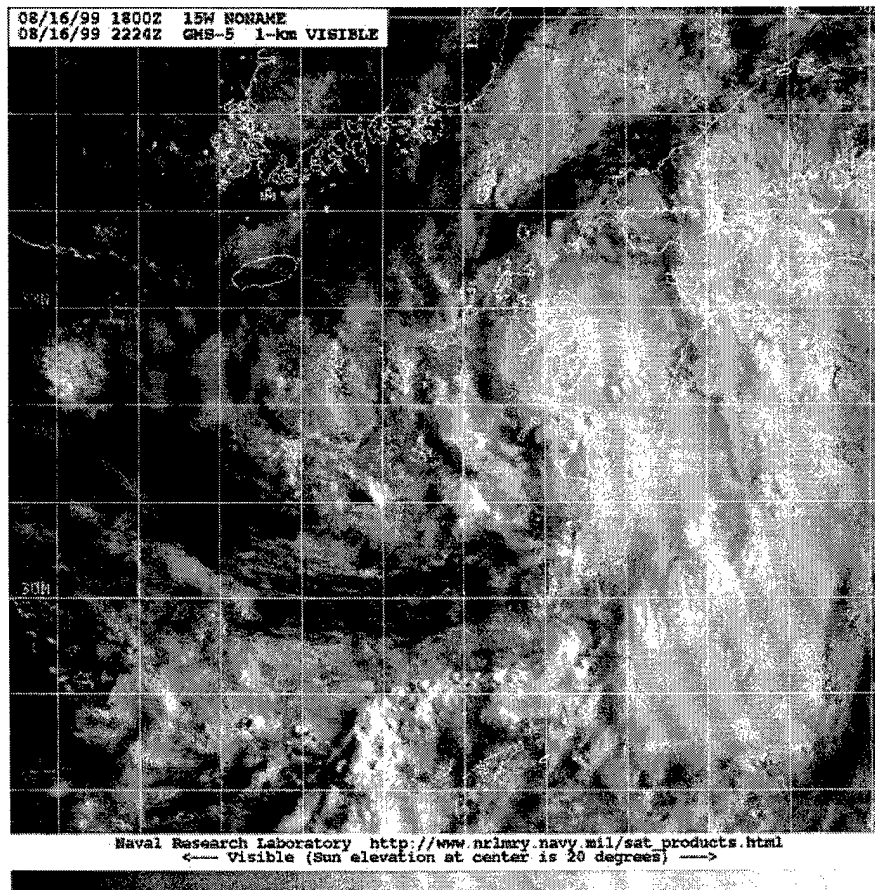


Figure 1-15-2. 162224Z August GMS-5 visible image. TD 15W was a 25 kt TD as it approached Kyushu, Japan. TD 15W made landfall 4 hours later over Kyusho.

## Typhoon Sam (16W)

Typhoon (TY) Sam (16W) formed over the Philippine Sea in mid August and tracked northwestward across northern Luzon into the South China Sea then made landfall over Hong Kong before dissipating in Southern China. TY Sam reached a peak intensity of 75 kt just before making landfall near Hong Kong, China and caused significant damage in the Philippines and China.

TY Sam (16W) developed as a large circulation with monsoon depression characteristics and maximum winds on the periphery. JTWC issued a TCFA at 172330Z August as satellite analysis indicated an increase in the organization of convection in the area. JTWC issued the first tropical cyclone warning at 30 kt intensity nine hours later as the developing cyclone moved slowly northwestward. TY Sam achieved tropical storm strength at 190000Z and typhoon strength two days later at 210600Z.

As TY Sam (16W) intensified, the subtropical ridge to the north became more influential as a steering influence, adding a westward component to its previous northward track. TY Sam tracked across northern Luzon at tropical storm strength before entering the South China Sea and intensifying to typhoon strength. TY Sam made landfall about 10 nm northeast of Hong Kong with typhoon strength winds of 75 kt, then moved northwestward over southern China for 24 hours before dissipating. JTWC issued the 20th and final warning on 230300Z August.

Fatalities from the system included seven in the Philippines and 17 dead in China. CNN reported three fatalities and over 200 injured when a plane tried to land during storm passage and crashed at Hong Kong International Airport. The Hong Kong Observatory reported TY Sam was the wettest tropical cyclone to affect Hong Kong since 1926.

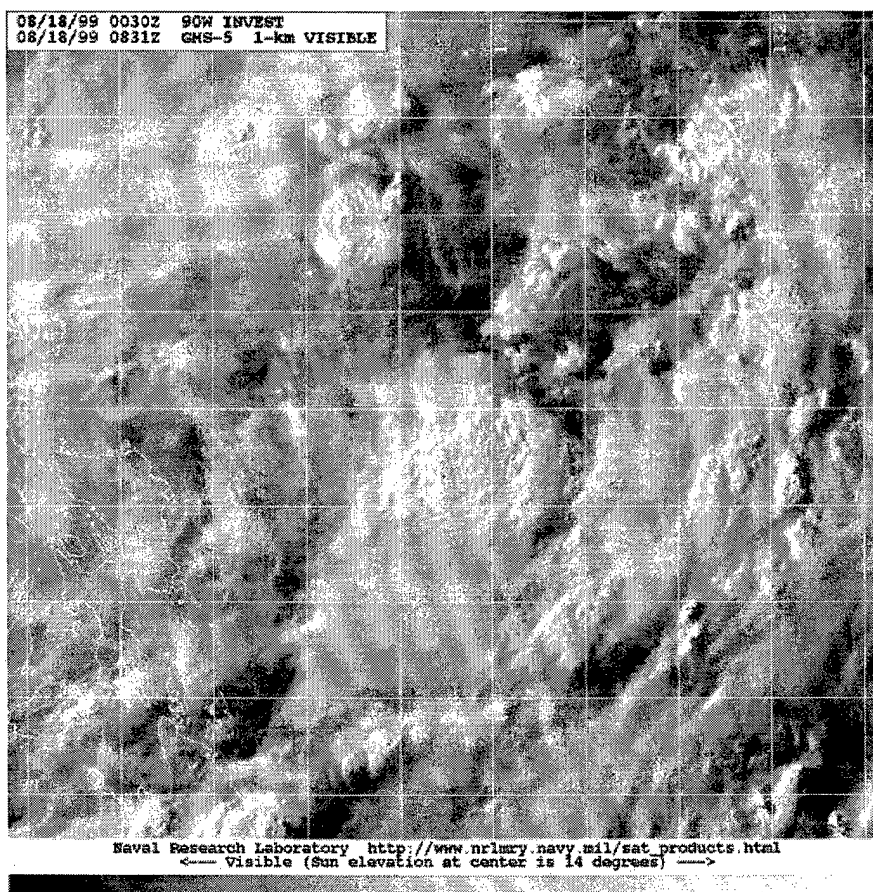


Figure 1-16-1. 180831Z August GMS-5 visible image of TY Sam (16W) shortly after the first warning. Notice the broad circulation and monsoon depression characteristics. TY Sam was at 30 kt intensity.

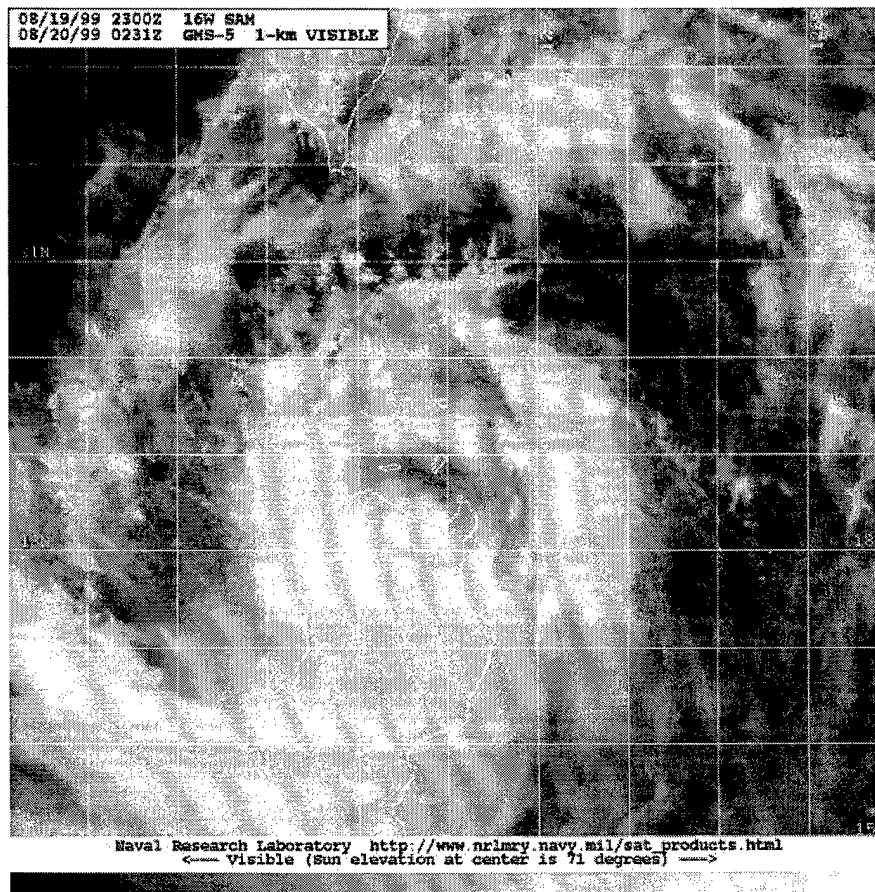


Figure 1-16-2. 200231Z August GMS-5 visible image of TY Sam (16W) as it tracked over northern Luzon. The large areal extent of the circulation is clearly visible. TY Sam was at 50 kt intensity.

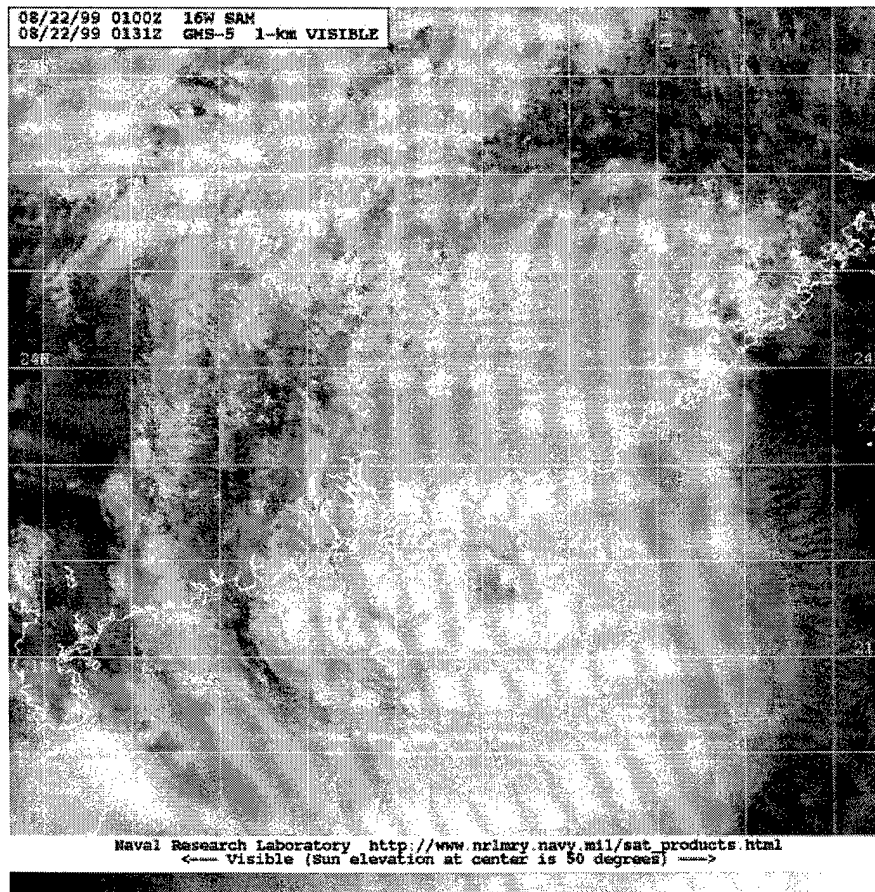
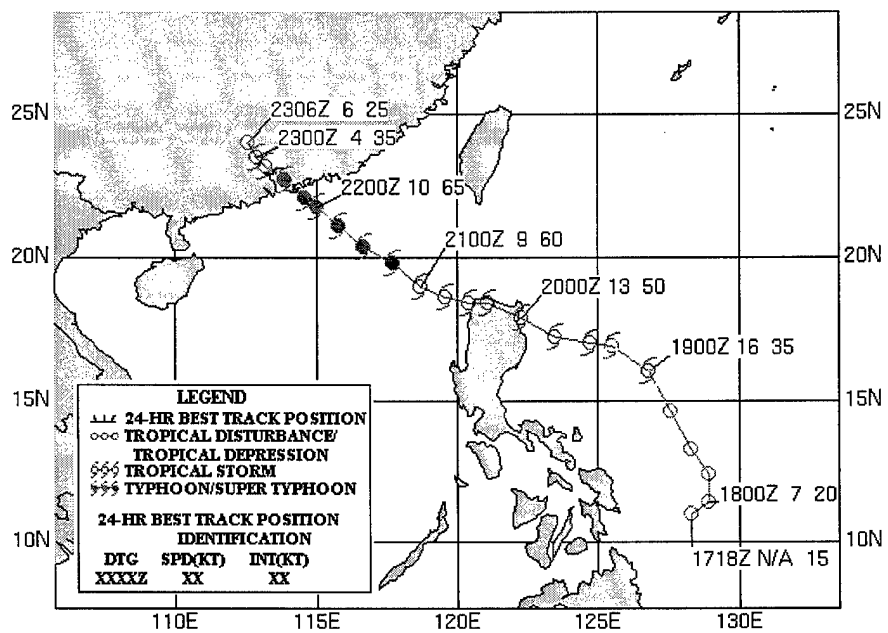


Figure 1-16-3. 220131Z August GMS-5 visible image of TY Sam (16W) at its peak intensity of 75 kt, just before making landfall northeast of Hong Kong.



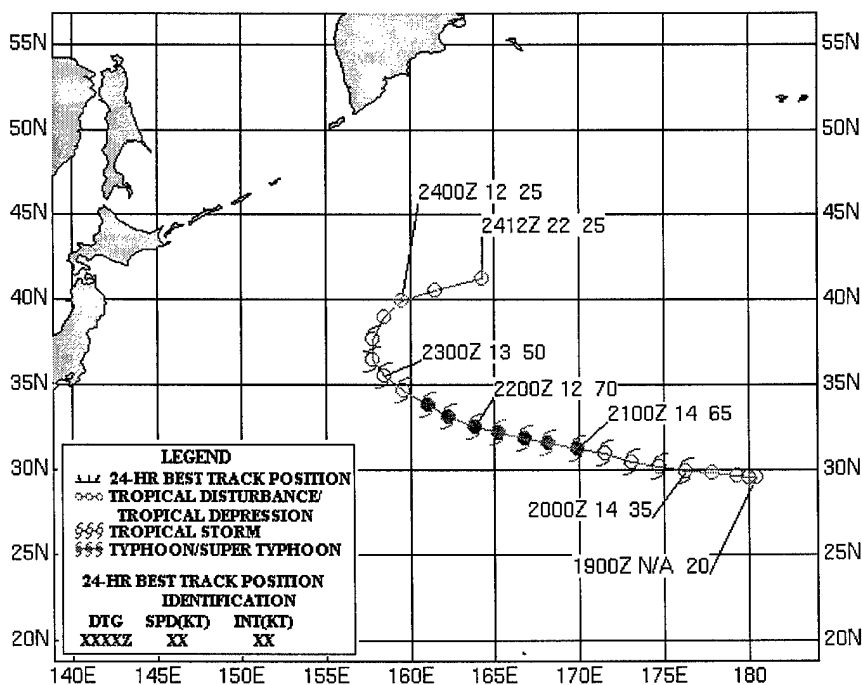
## Typhoon Tanya (17W)

Typhoon (TY) Tanya (17W) was a small-sized tropical cyclone which formed just west of the dateline during mid August. It tracked west-northwestward before recurving toward the northeast and becoming extratropical. This cyclone reached a peak intensity of 70 kt just before recurving to the northeast and dissipating over water.

Based on meteorological satellite data, which indicated a tightly wrapped low level circulation, JTWC issued a TCFA at 191530Z August. As the convection became more organized, JTWC issued the first tropical cyclone warning for a 30 kt intensity at 192100Z August. Post analysis adjusted this to 40 kt.

Typhoon Tanya (17W) initially tracked westward under the steering influence of a subtropical ridge to its north. TY Tanya began recurvature through a weakness in the subtropical ridge at 230900Z August and began to experience increased vertical wind shear. As TY Tanya weakened and began extratropical transition, JTWC issued the 18th and final warning at 240300Z August.

Of special note was the fact that Typhoon Tanya (17W) developed at unusually high latitude as a very small (midget) tropical cyclone that reached typhoon intensity.



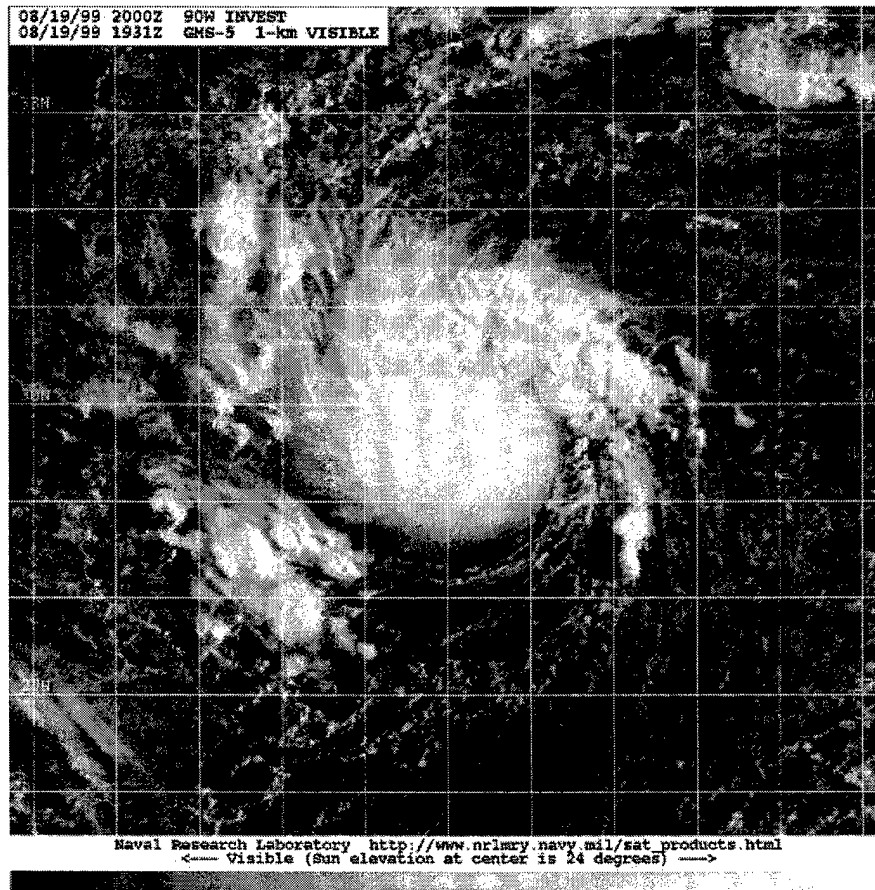


Figure 1-17-1. 191931Z August GMS-5 visible image of TS Tanya (17W) at an intensity of 40 kt. Image depicts the intense convection associated with the small, tightly wrapped low-level circulation.



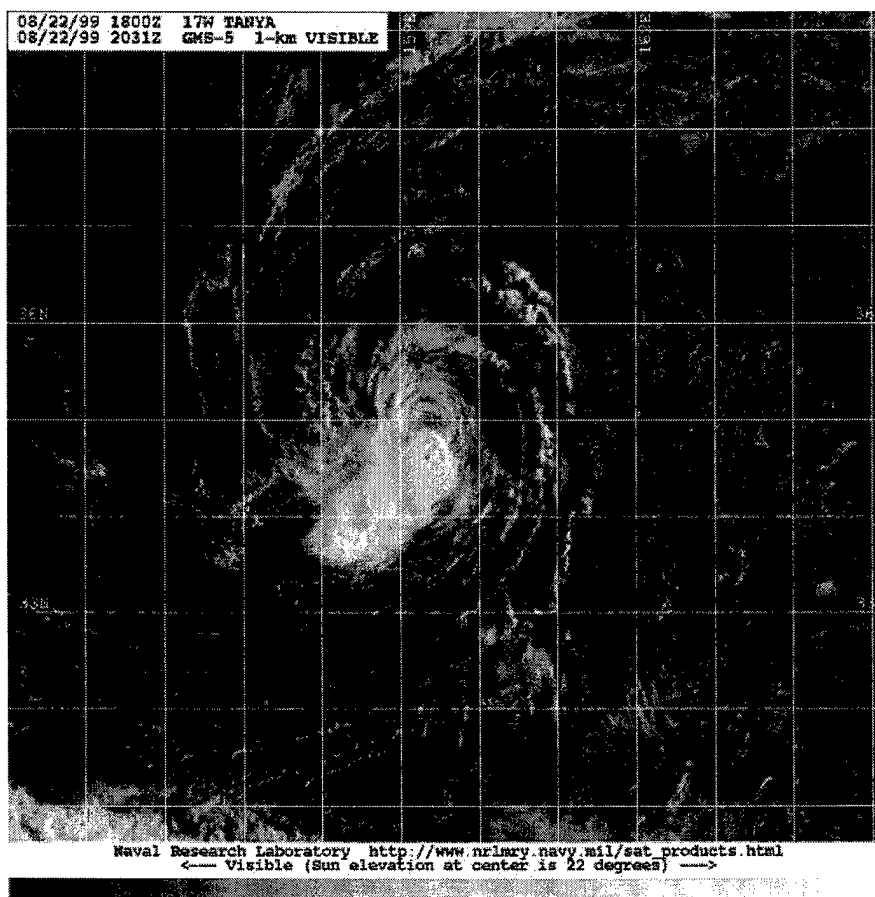


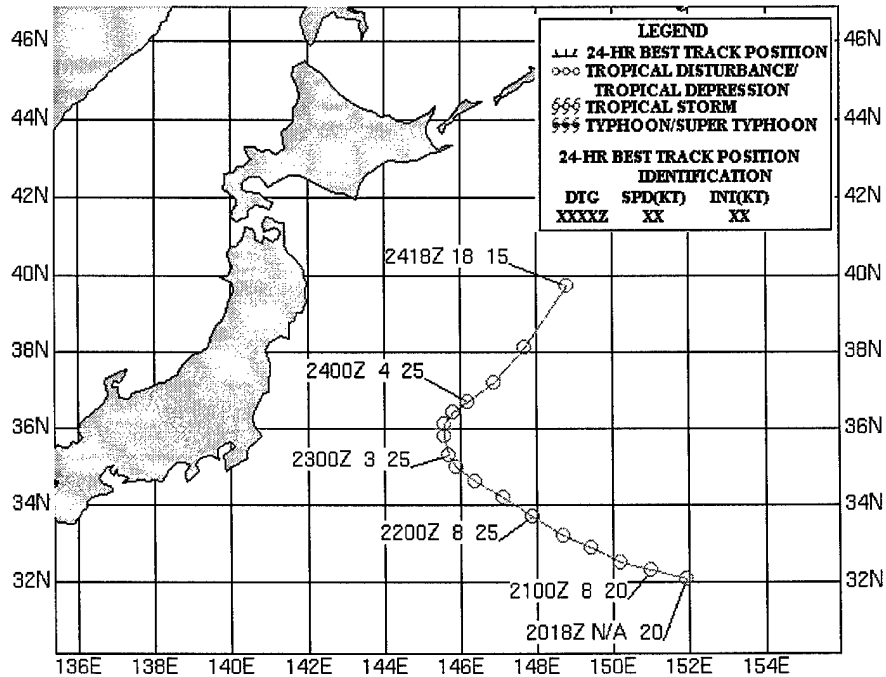
Figure 1-17-2. 222031Z August GMS-5 visible image of TY Tanya (17W). This image depicts the exposed low-level circulation center with deep convection being sheared to the south. Intensity at this time was 60 kt.

# Tropical Depression 18W

Tropical Depression (TD) 18W was one of three very small (midget) tropical cyclones warned on by JTWC during the 1999 season. This cyclone developed at the tail end of a shearline then moved west and recurved, becoming an extratropical cyclone after 4 days.

TD 18W formed approximately 640 nm east of Tokyo, Japan and JTWC first mentioned the area on the 192251Z August re-issuance of the ABPW. The first warning on TD 18W was issued at 212100Z August and by 221200Z August, the cyclone had reached a maximum intensity of 30 kt. Vertical wind shear caused TD 18W to become an exposed low level cyclone after 090000Z August.

TD 18W moved at 8 kt for the initial 36 hours then began to slow as it recurved northeastward on 221200Z August. The system moved at 3-5 kt until 240000Z August then accelerated and moved into the same frontal boundary it developed from. JTWC issued the 10th and final warning at 240300Z August as TD 18W weakened and became extratropical.



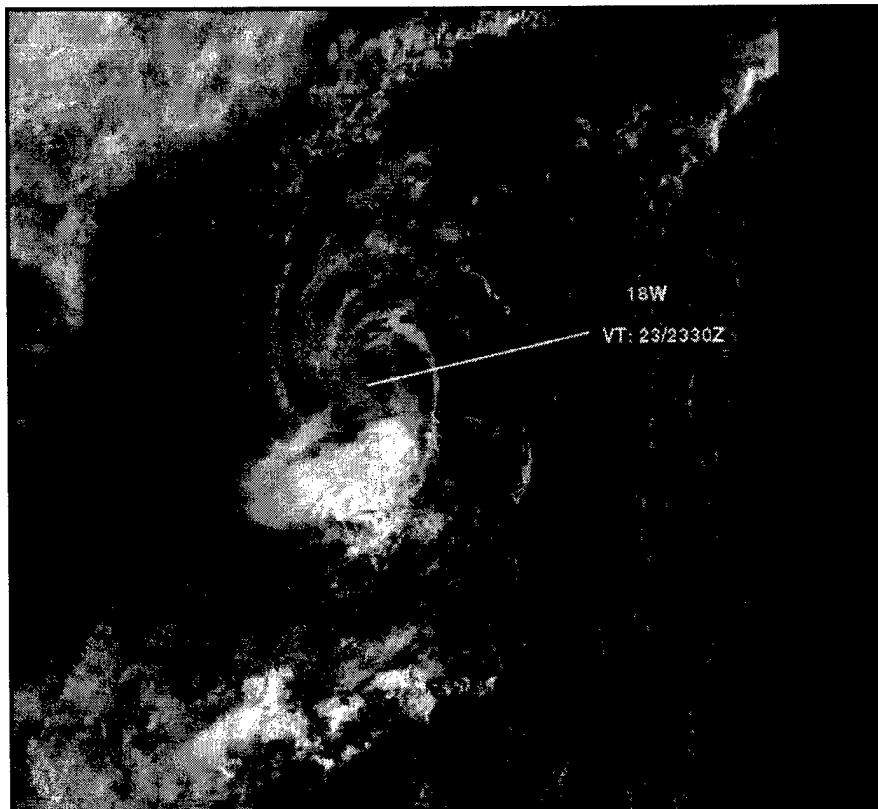


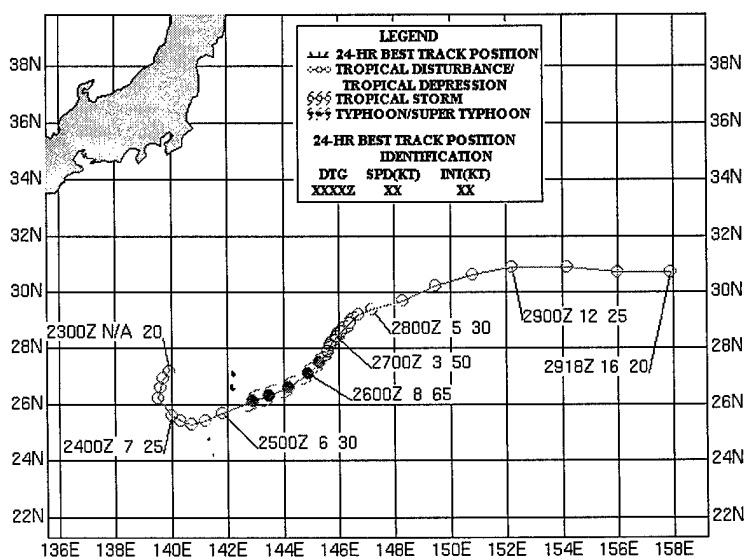
Figure 1-18-1. 232330Z visible image shows strong vertical windshear over TD 18W shearing the convection to the south of the exposed low-level circulation center (LLCC). Of note in this image is the tight wrap of the cloud lines into the LLCC. Current intensity was estimated at 25 kt.

## Typhoon Virgil (19W)

Typhoon (TY) Virgil (19W) developed as a very small-sized (midget) tropical cyclone at the end of a quasi-stationary shear line north-northwest of Iwo Jima. After a short southward jog, TY Virgil moved east, intensified to a peak intensity of 70 kt, and then dissipated over water after 7 days. TY Virgil was one of three midget tropical cyclones JTWC warned on during the 1999 season. All three developed within the mid-latitude region of the Northwest Pacific.

JTWC identified the area which was to become TY Virgil (19W) on the 230600Z August ABPW and subsequently issued a TCFA at 230930Z August as a tropical upper-level trough (TUTT) moved to the east and vertical wind shear decreased. After a scatterometer pass indicated 25 kt winds, JTWC issued the first warning at 240300Z August. Between the 250300Z warning and 250600Z August, the cyclone rapidly intensified from 30 kt to 65 kt. Shortly after reaching typhoon intensity, TY Virgil reached a maximum intensity of 70 kt at around 251200Z August.

TY Virgil (19W) initially moved counter-clockwise while a tropical depression. As the cyclone began to develop further, it moved more rapidly, but then slowed as it again interacted with the TUTT. After the cyclone became vertically sheared, it accelerated rapidly in the low level steering flow, interacting with a passing mid-latitude front and continued to weaken as it became absorbed into the boundary. JTWC issued the 21st and final warning at 290300Z August as the cyclone dissipated over water.



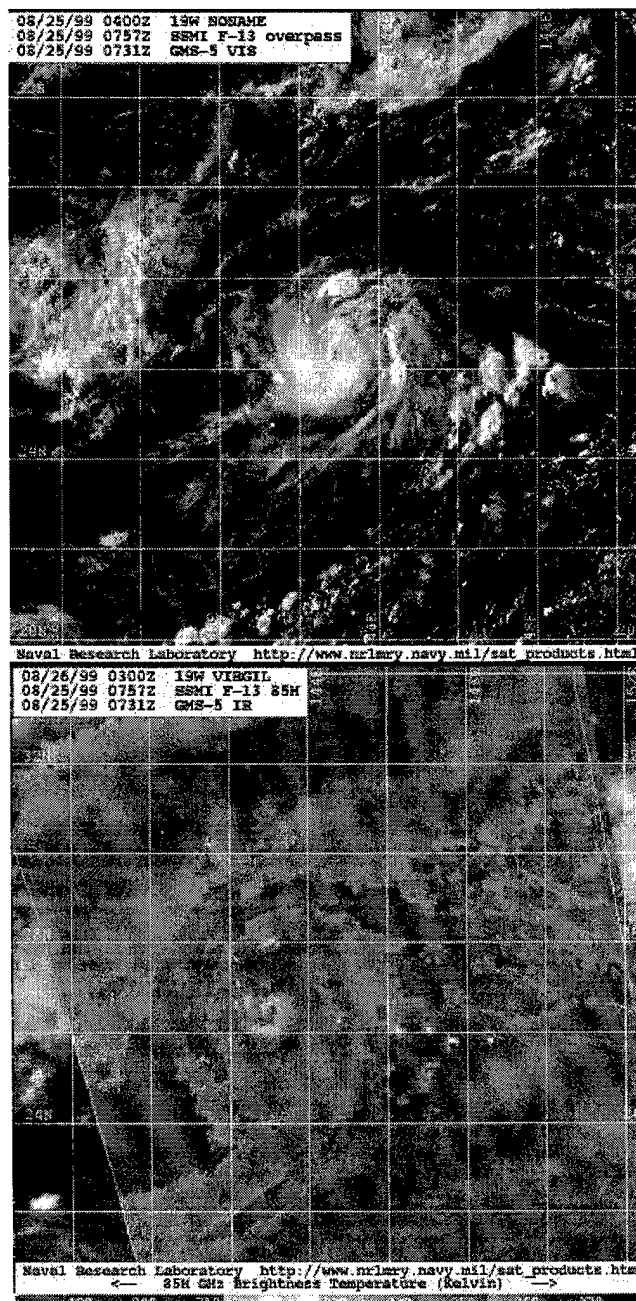


Figure 1-19-1. 250757Z microwave and 250731Z August visible imagery showing the low level circulation center of TY Virgil (19W) as it reached typhoon intensity (65 kt). Visible imagery indicates a possible eye, but the microwave image leaves little doubt.

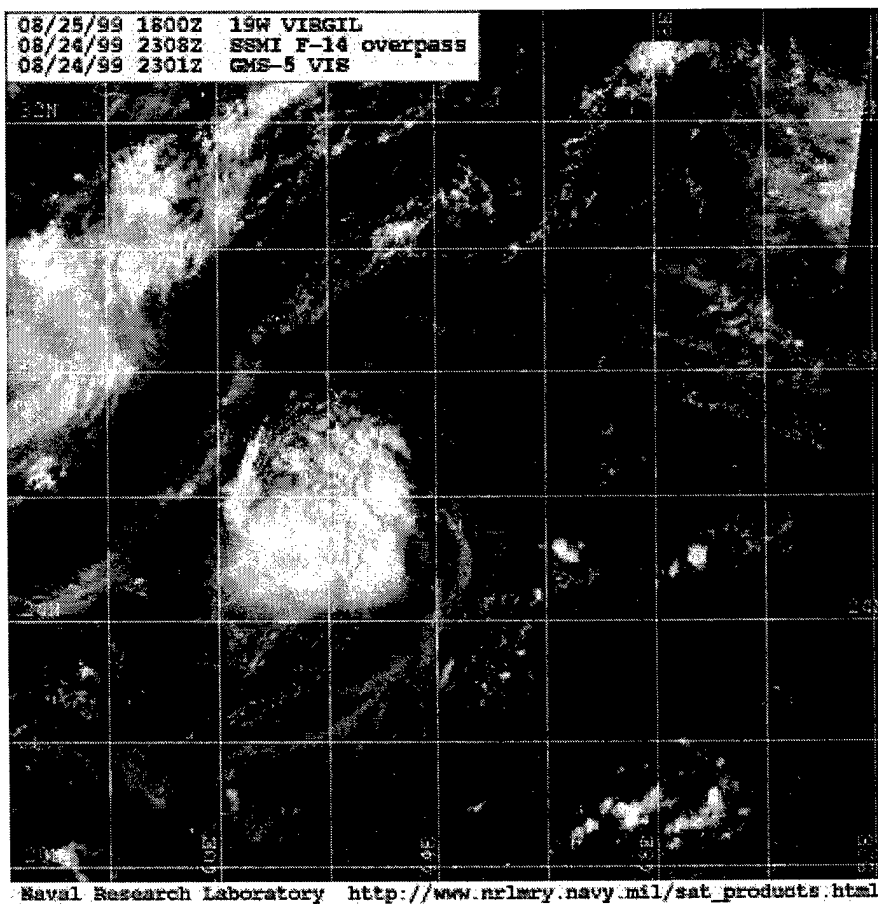


Figure 1-19-2. 242308Z visible image showing the tropical disturbance that 6 hours later developed into TY Virgil (19W) with an intensity of 65 kts. This explosive development was the result of the the upper-tropospheric low filling, and no longer restricting the outflow of the system.

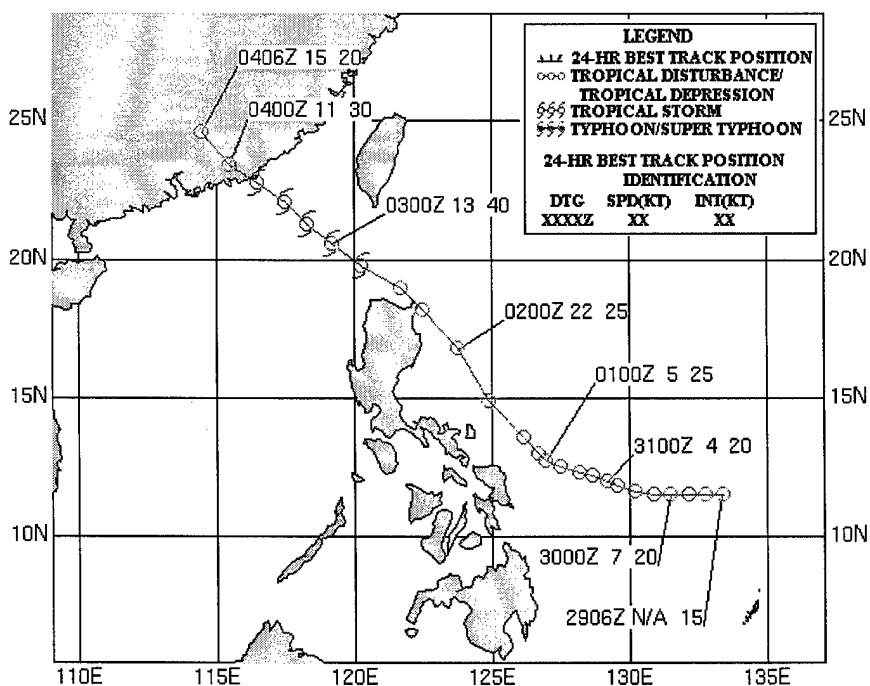
## Tropical Storm Wendy (20W)

Tropical Storm (TS) Wendy (20W) formed over the Philippine Sea then tracked northwestward clipping northeastern Luzon, to make landfall in southeast China, east-northeast of Hong Kong about 5 days after initial detection. This cyclone attained a peak intensity of 40 kt while passing through the northern portion of the South China Sea.

A Tropical Cyclone Formation Alert was issued at 310230Z August as convection developed over a broad low-level circulation. This convection continued to slowly consolidate and the first warning was issued at 010300Z September for a 25 kt tropical depression.

This cyclone continued to track northwestward while accelerating and then slowed and turned more westward after skirting the northeastern coast of Luzon. TS Wendy (20W) reached a maximum intensity of 40 kt in the South China Sea at 030300Z September then made landfall approximately 120 nm east-northeast of Hong Kong at 031900Z September as a 40 kt tropical storm.

JTWC issued the 13th and final warning on 040300Z as TS Wendy moved inland and dissipated. The Hong Kong Observatory reported no significant damage.



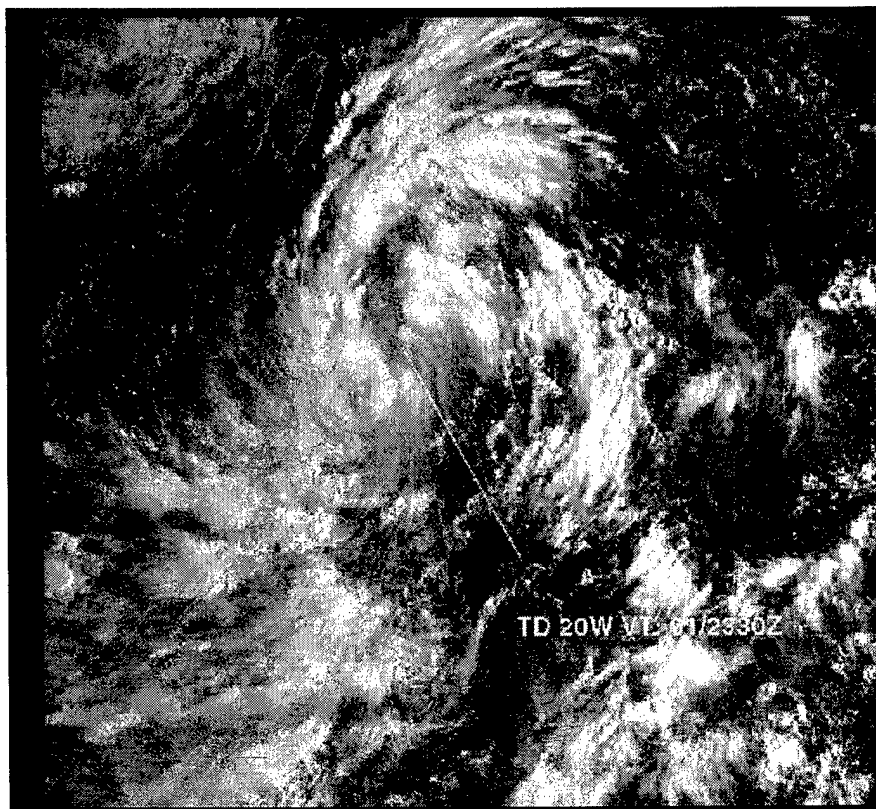


Figure 1-20-1. 012330Z September visible satellite image of a developing TS Wendy (20W) at 25 kt intensity, just east of Luzon.



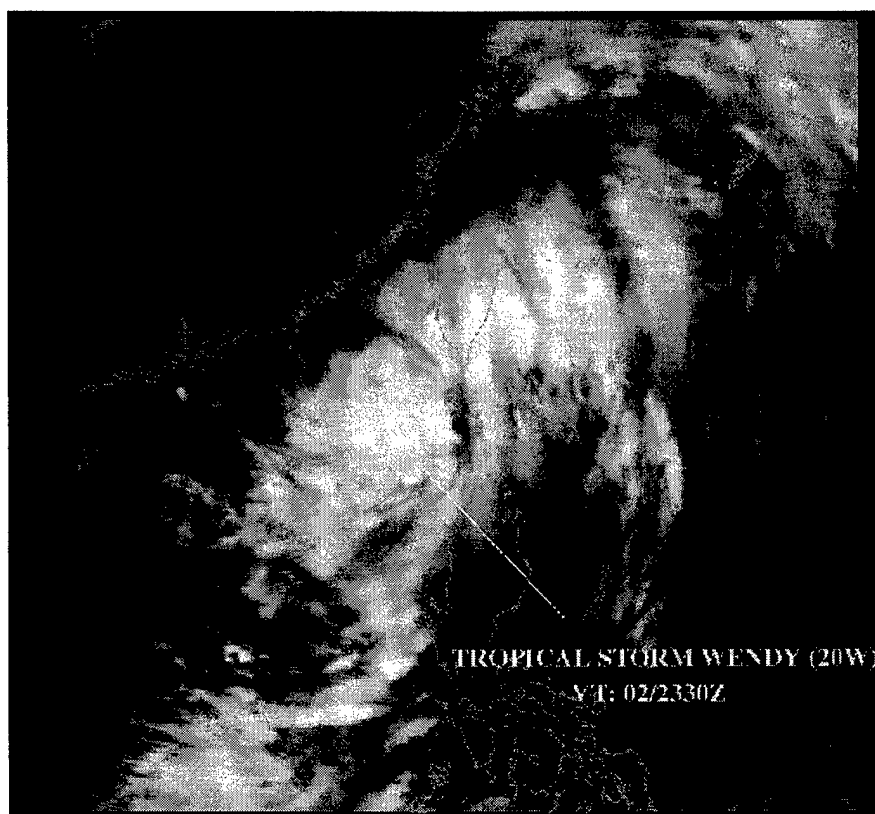


Fig 1-20-2. 022330Z September visible satellite image of Tropical Storm Wendy (20W) at its maximum intensity (40 kt), southwest of Taiwan.

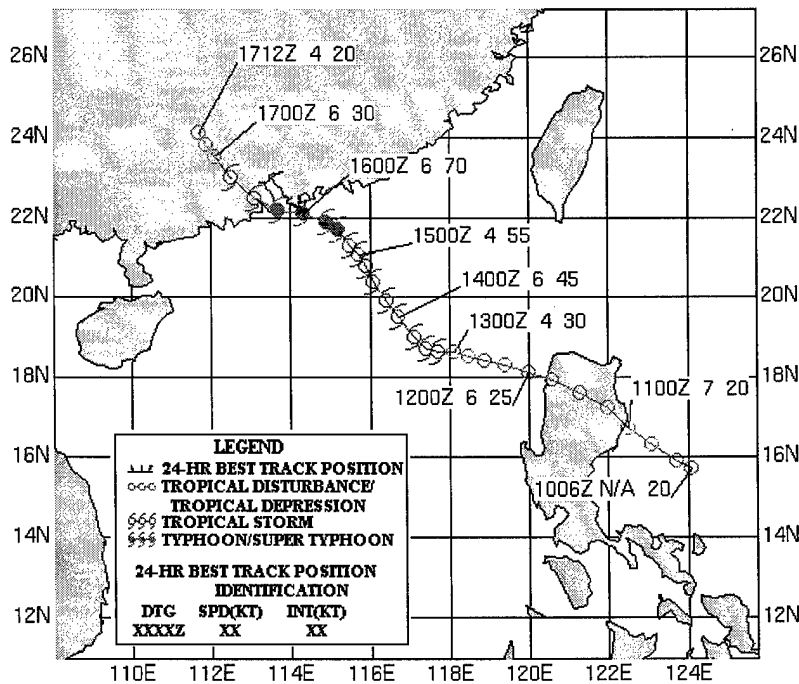
# Typhoon York (21W)

Typhoon York (21W) initially formed in the Philippine Sea, slowly intensified in the South China Sea, and proceeded northwest into Hong Kong. News reports stated it was the worst tropical cyclone to hit Hong Kong in 16 years.

The disturbance that became Typhoon York developed in a broad region of cyclonic low level flow and scattered deep convection in the Philippine Sea. JTWC began tracking the disturbance on 061200Z September and issued a Tropical Cyclone Formation Alert (TCFA) at 100300Z September. The cloud system however, failed to develop as it began to interact with the terrain of Luzon. A second TCFA was issued 24 hours later as upper-level outflow became more favorable, and the mid-level vortex appeared to reconsolidate and organize in a region of deep convection.

The first warning was issued at 112100Z as a 25 kt tropical depression as the system began to slowly intensify and track northwestward, it subsequently attained tropical storm intensity over the South China Sea around 130900Z September (Figure 1-21-1). Typhoon York (21W) peaked at 70 kt on 151800Z as it moved toward Hong Kong and made landfall near 160900Z (Figure 1-21-2). JTWC issued the 22nd and final warning at 170300Z as the cyclone moved inland and dissipated.

The Hong Kong Observatory reported 2 fatalities with more than 500 people injured and direct economic losses, amounting to several billion Hong Kong dollars. The Hong Kong Observatory further reported that the last time typhoon force winds were measured in Hong Kong was in 1983.



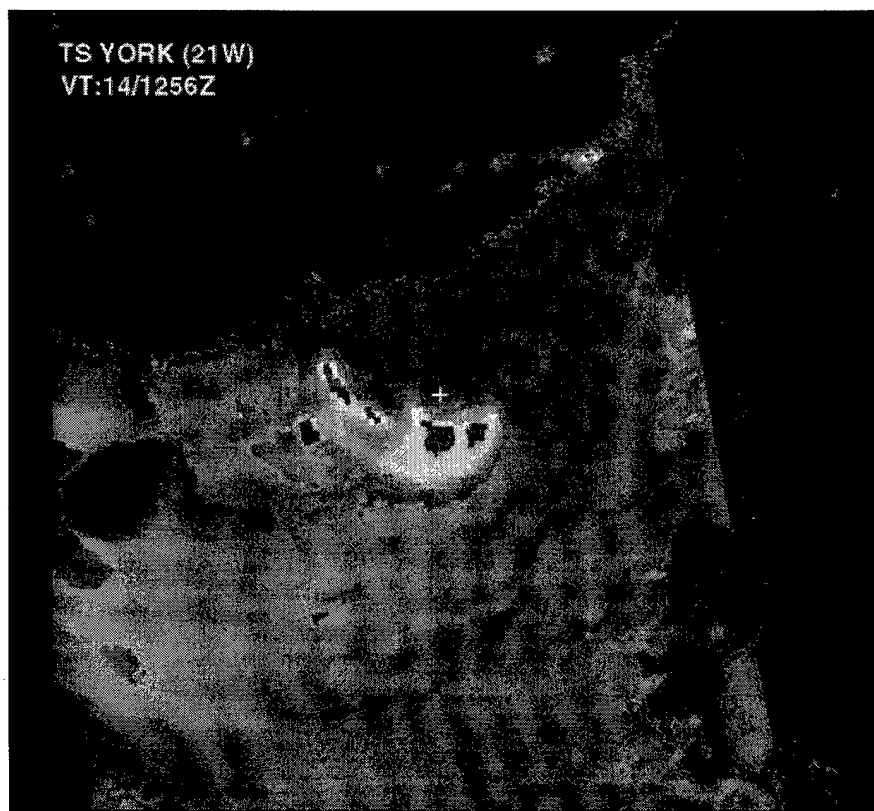


Figure 1-21-1. A special sensor microwave satellite image of developing Tropical Storm York (21W) at 141256Z September, in the South China Sea southeast of Hong Kong.

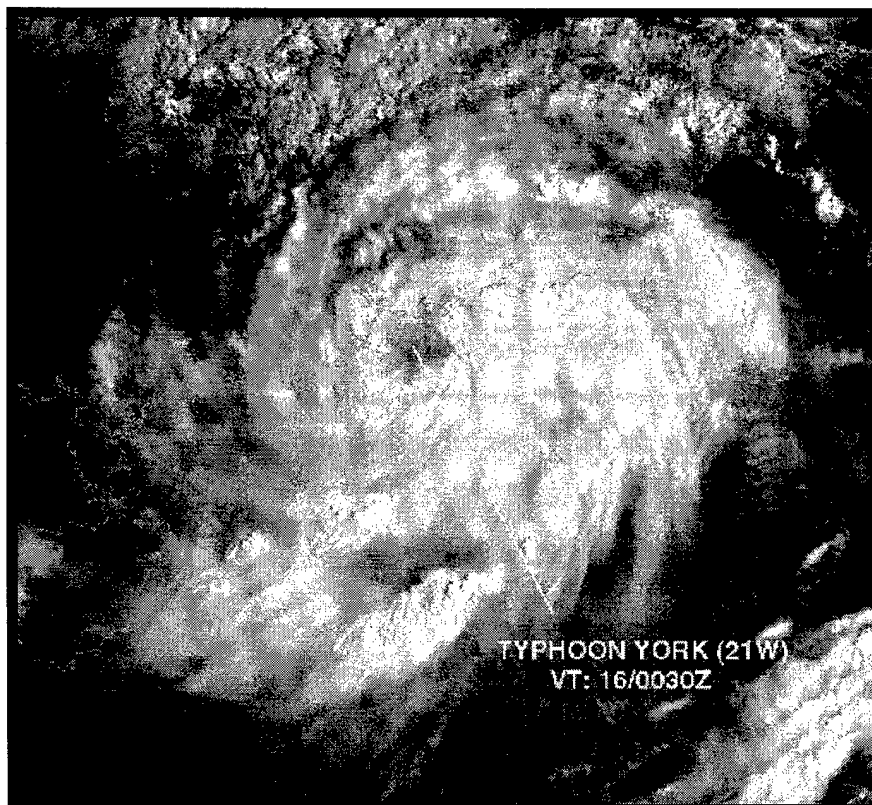


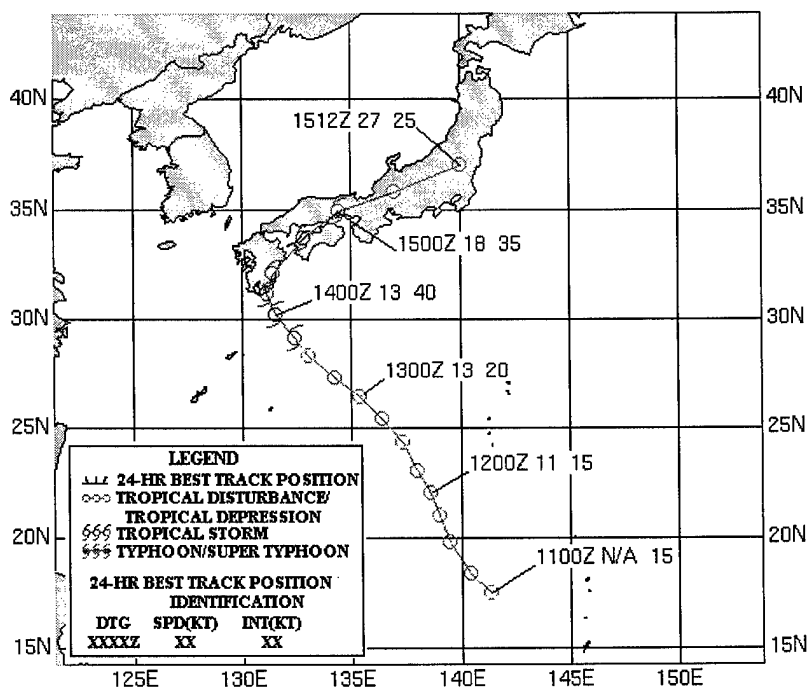
Figure 1-21-2. A visible geostationary satellite image of Typhoon York (21W) near peak intensity at 160030Z September, near Hong Kong.

## Tropical Storm Zia (22W)

Tropical Storm (TS) Zia (22W) formed in the Philippine Sea and tracked northwestward making landfall approximately 50 nm south of Kushima, Kyushu with a maximum intensity of 45 kt. TS Zia then tracked over Honshu and dissipated.

TS Zia (22W) developed as a disturbance in the monsoon trough west of the Mariana Islands. JTWC began tracking the disturbance on 110000Z September and issued a Tropical Cyclone Formation Alert (TCFA) at 121000Z September. JTWC subsequently cancelled the TCFA as the convection associated with the low level circulation center (LLCC) was displaced well to the south. On 131730Z September, JTWC reissued a TCFA as convection began to rebuild over the exposed LLCC and outflow aloft dramatically improved due to the presence of a tropical upper-tropospheric low positioned to the northwest of the low level circulation center.

The first warning was issued at 132100Z September for a 35 kt tropical storm. TS Zia (22W) peaked at 45 kt on 140600Z as it moved toward the coast of Kyushu and made landfall at 140730Z. JTWC issued the 7th and final warning at 150900Z as the cyclone weakened to 20 kt and merged with a shear line near Fukushima, Honshu.



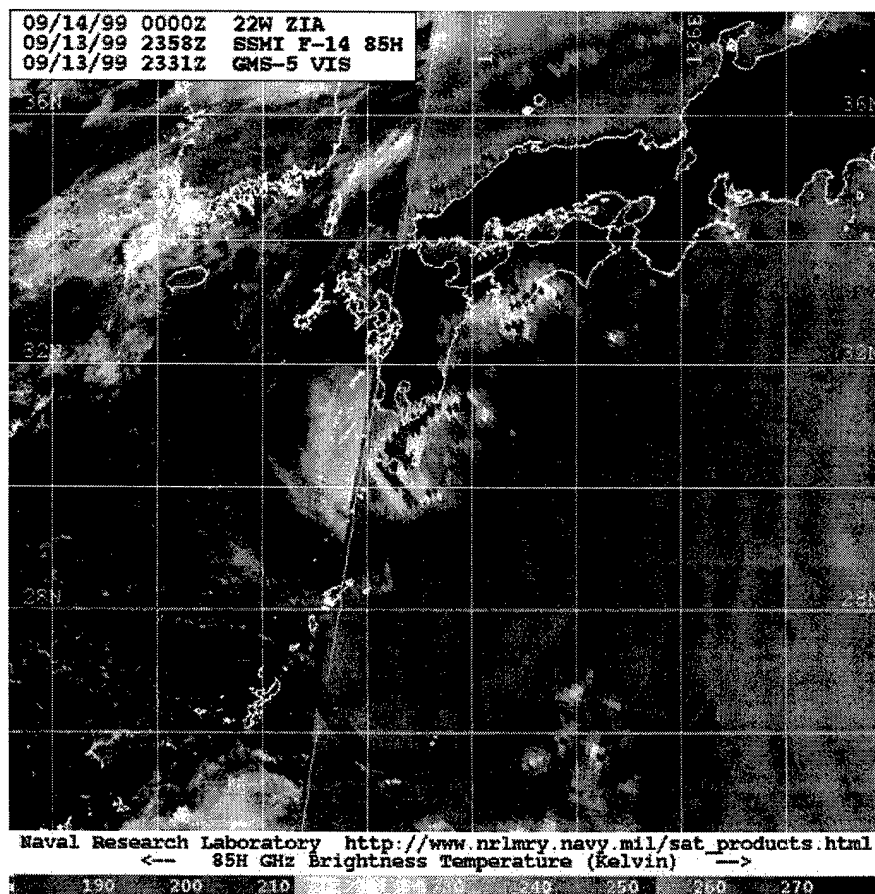


Figure 1-22-1. 132358Z September Special Sensor Microwave Imager pass depicting TS Zia (22W) just before it moved over the Kyushu coast as a 45 kt system.

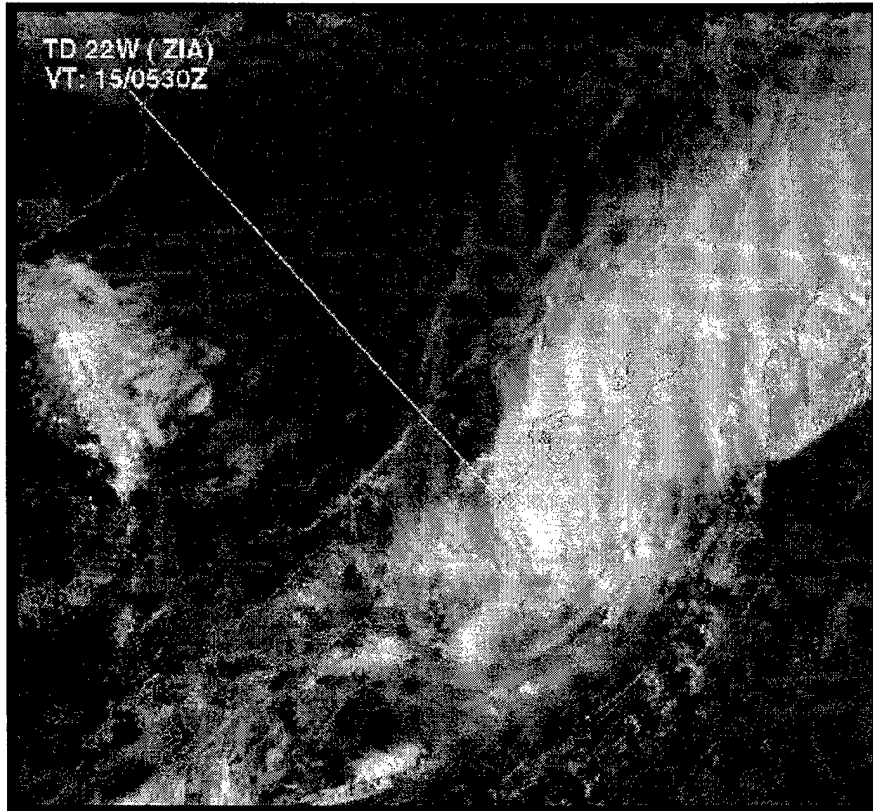


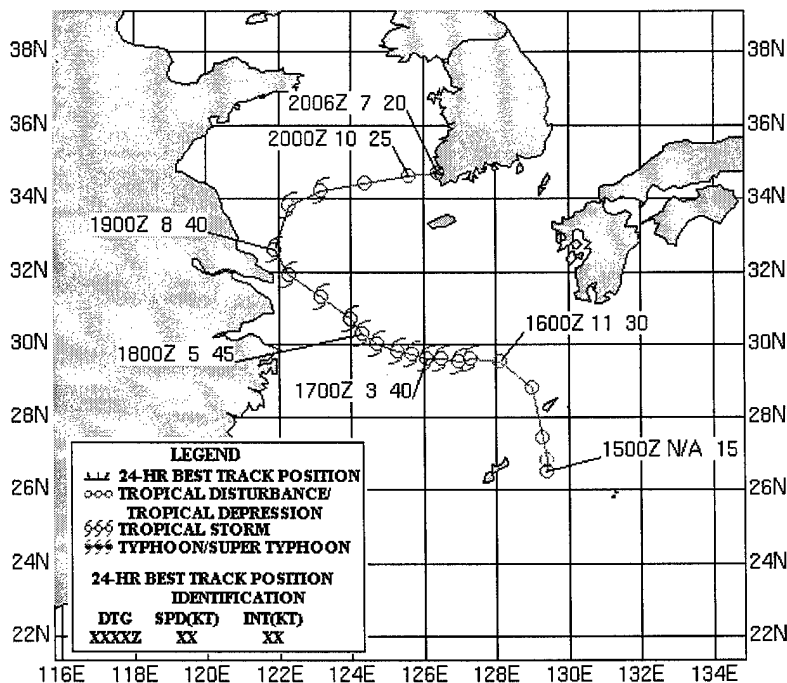
Figure 1-22-2. 150530Z September GMS-5 visible image shows TS Zia (22W) as an extratropical system along a shear line. Current intensity is 30 kt.

## Tropical Storm Ann (23W)

Tropical Storm (TS) Ann (23W) formed about 90 nm east of Okinawa in mid September. This cyclone peaked at 45 kt over the southern portion of the Yellow Sea and then weakened as it moved under moderate to strong mid-latitude westerlies before dissipating on 20 September near the southwest coast of the Republic of Korea (ROK).

TS Ann (23W) initially tracked northward under the weak low/mid-level steering influence of the sub-tropical high over the northern Mariana Islands. JTWC issued the first warning on 152100Z September as a tropical depression. TS Ann then took a northwestward track, and reached a maximum intensity of 45 kt on 171200Z September.

TS Ann (23W) remained at 45 kt until 19 September. TS Ann then began to weaken under a moderate vertical wind shear environment generated by the mid-latitude westerlies. TS Ann then took a more northward track as the ridge over southern Japan began to weaken with the approach of a mid-latitude shortwave trough from the northwest. As the trough moved over the Yellow Sea, TS Ann tracked eastward dissipating near Makp'o ROK on 20 September. JTWC issued the 18th and final warning at 200300Z September.





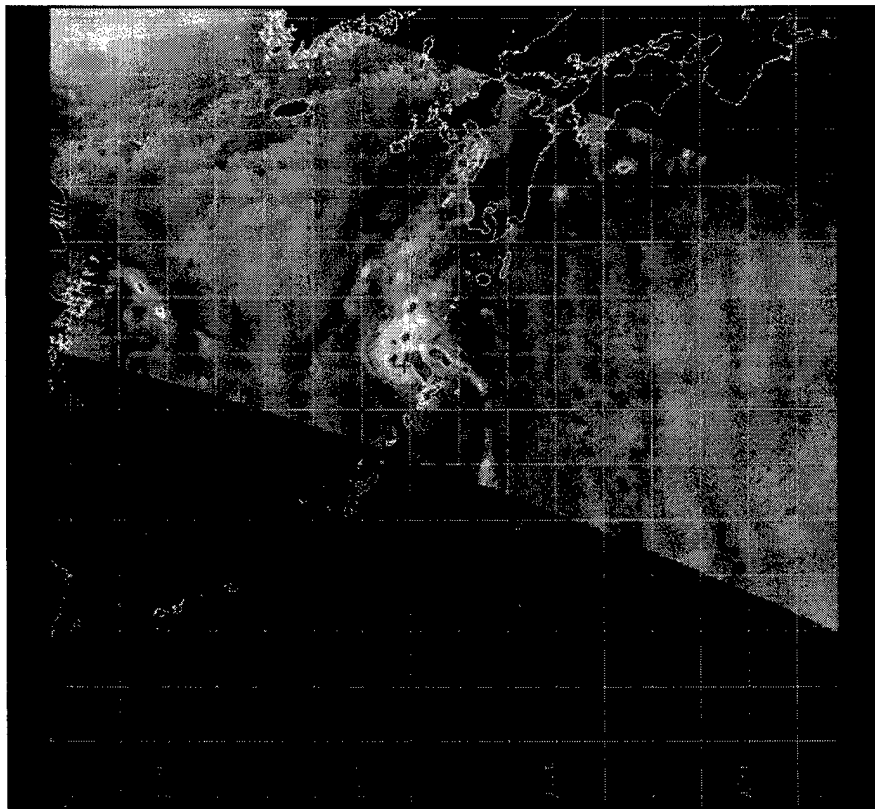


Figure 1-23-1. A Tropical Rainfall Measuring Mission (TRMM) pass of TS Ann (23W) at 30 kt at 151744Z September, off the west coast of Okinawa.

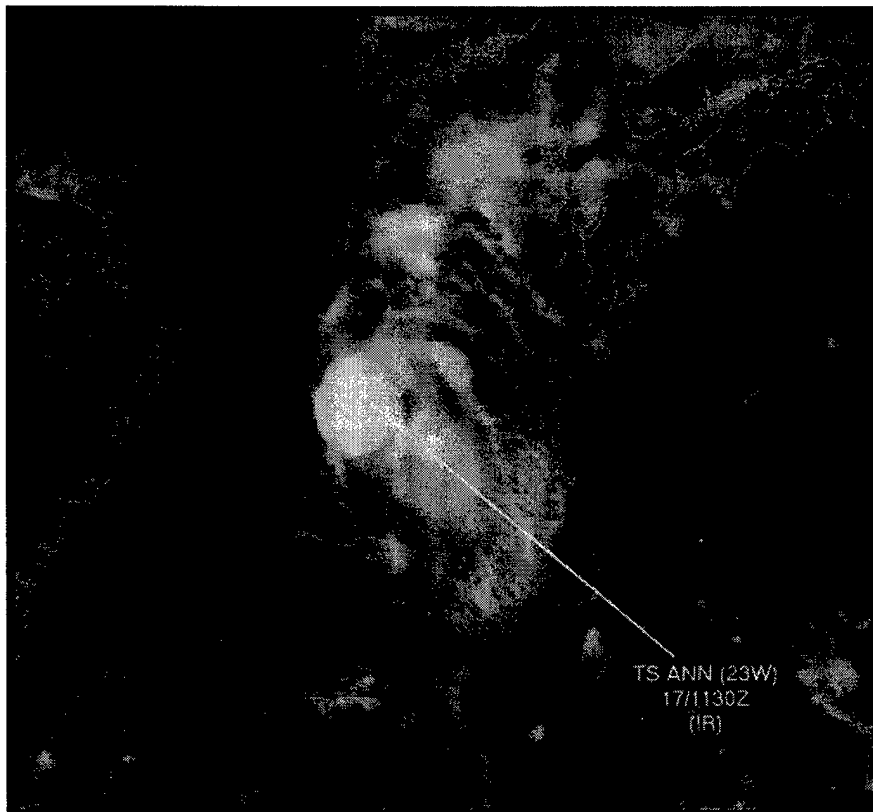
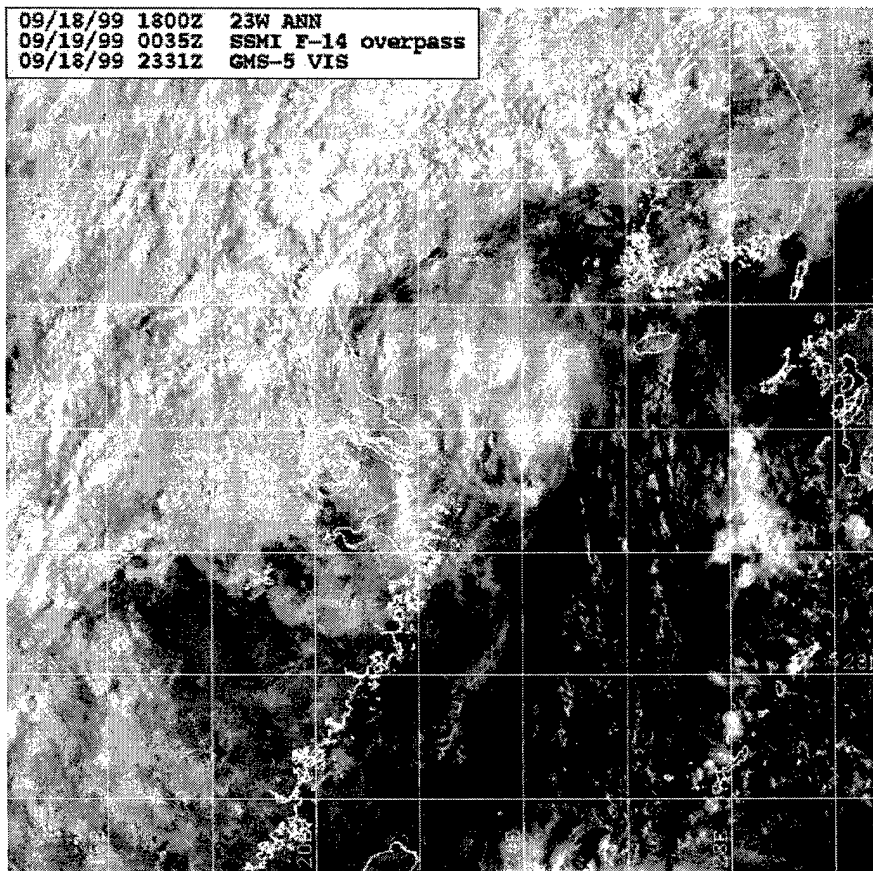


Figure 1-23-2. GMS-5 infrared image of TS Ann (23W) at 171130Z September over the Yellow Sea. Current intensity is 45 kt.

09/18/99 1800Z 23W ANN  
09/19/99 0035Z SSMI F-14 overpass  
09/18/99 2331Z GMS-5 VIS



Naval Research Laboratory [http://www.nrlmry.navy.mil/sat\\_products.html](http://www.nrlmry.navy.mil/sat_products.html)

Figure 1-23-3. A GMS-5 visible image of TS Ann (23W) at 182331Z September. The image reveals the mid-latitude system to the northwest and a weakening, less organized, tropical cyclone. Current intensity is 40 kt.

## Super Typhoon Bart (24W)

Super Typhoon (STY) Bart (24W), the only super typhoon of the season, developed in the Philippine Sea, south of a pronounced Tropical Upper Tropospheric Trough (TUTT) cell and gradually intensified into the most intense tropical cyclone of the 1999 Northwest Pacific season. STY Bart intensified at a climatological rate until reaching a maximum intensity of 140 kt. The system tracked generally northward and impacted Japan's southernmost islands then moved into the Sea of Japan where rapid northeastward acceleration and extratropical transition occurred.

STY Bart (24W) originated as a weak low level circulation south of a broad TUTT cell, just off the east coast of Taiwan. A Tropical Cyclone Formation Alert was issued at 170300Z September. Initially, poor outflow aloft suppressed development of the circulation and weak low level steering flow created a quasi-stationary environment. As the TUTT cell moved northwestward and began to fill, STY Bart slowly developed with improving outflow aloft. The first warning was issued at 171500Z September as a 25 kt system.

STY Bart (24W) initially tracked northwestward and continued to slowly intensify. Shortly after reaching typhoon intensity at 200000Z September, the cyclone slowed its northwestward track as it moved into a region of weak steering flow between the subtropical ridge cells to the east-northeast and west. STY Bart became nearly quasi-stationary with a slight northward drift. The system then drifted slowly northeastward as it continued to intensify at a climatological rate.

As STY Bart (24W) approached Okinawa, it reached Super Typhoon intensity at 211800Z September and began a slow acceleration northward, passing 40 nm west of Okinawa. STY Bart reached a maximum intensity of 140 kt at 220600Z September and remained very intense as it approached northwestern Kyushu, Japan. STY Bart then moved over the Sea of Japan and continued to accelerate toward the northeast. JTWC issued the 29th and final warning on STY Bart at 241500Z September, as the system became fully extratropical and moved over the northern Japanese island of Hokkaido, and continued to move back over the North Pacific.

STY Bart (24W) had a major impact on both military and civilian interests across the northern Philippine Sea and many parts of Japan. The Associated Press and the Japan Meteorological Agency reported 30 fatalities and 1314 injuries across Japan. Over 800,000 homes were left without power and 18,498 homes flooded due to very heavy rain and numerous landslides. Kadena Air Base on Okinawa reported over 28 inches of rain within a 48 hour period.

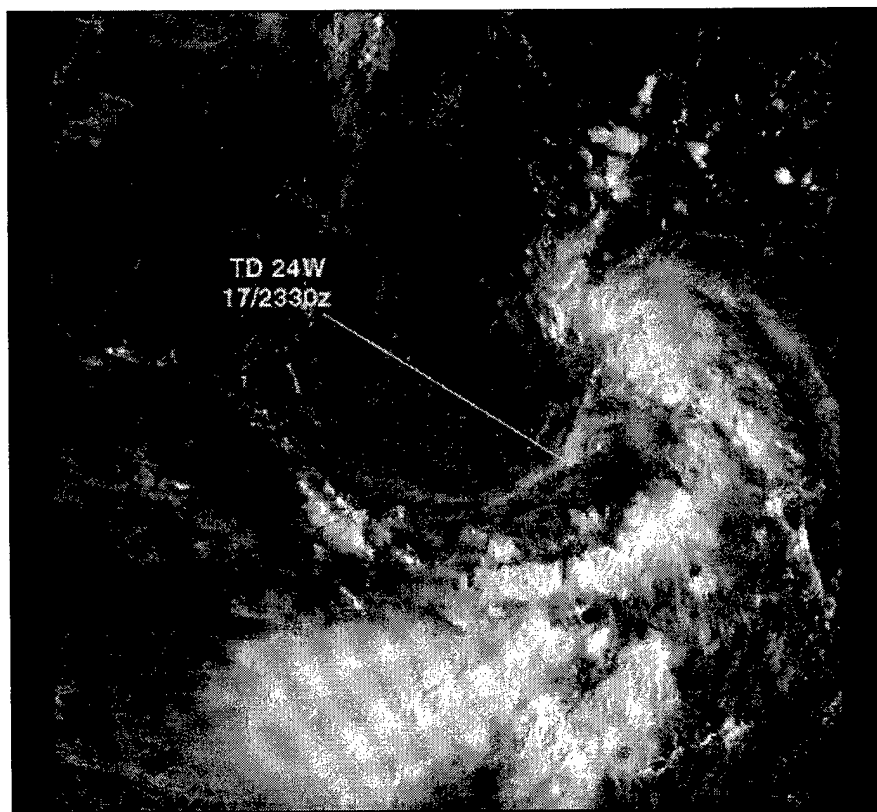


Figure 1-24-1. 172330Z September visible satellite image of STY Bart (24W) as a low-level circulation in the Philippine Sea, south of a TUTT cell (evident by the curved mid-level banding convection to the south and generally clear air to the northwest). This image was only 12 hours after the initial warning. TD 24W was at 25 kt intensity.

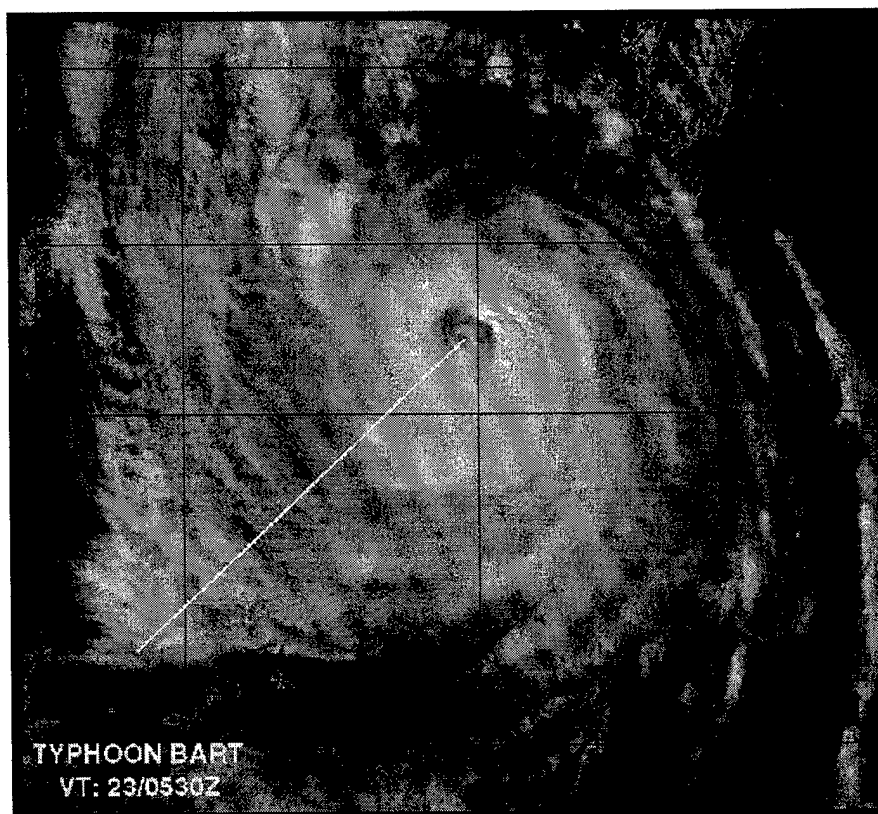
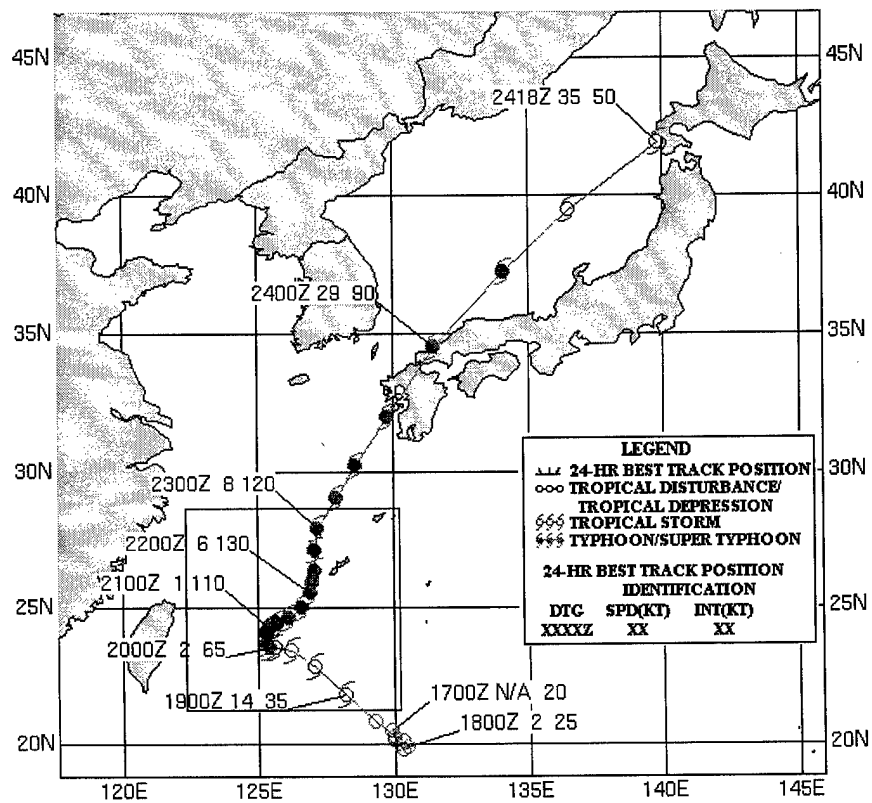


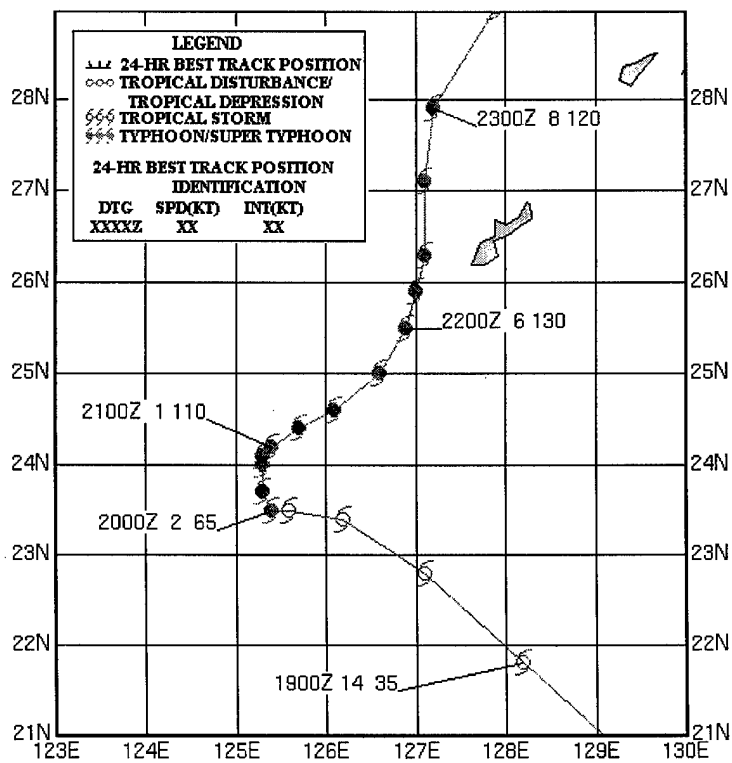
Figure 1-24-2. At 230530Z September, STY Bart (24W) was reaching maximum intensity of 140 kt just west of Japan's southern-most islands. This image reveals a double-eyewall structure.



Figure 1-24-3. STY Bart (24W) had quickly passed over Kyushu and was moving into the Sea of Japan in this 232330Z September visible image. Even after significant interaction with land, the cyclone maintained an impressive structure as it moved back over water.







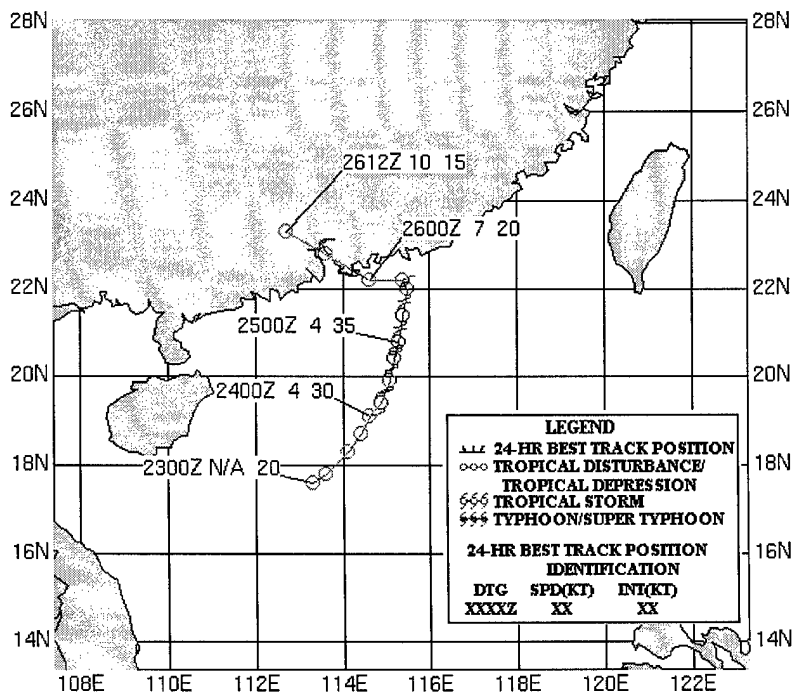
## Tropical Storm Cam (25W)

Tropical Storm (TS) Cam (25W) developed in the central South China Sea and became one of four significant tropical cyclones to affect Hong Kong in 1999. After moving north-northeastward for 60 hours, the cyclone abruptly changed direction toward the west and made landfall over Hong Kong as a 20 kt system.

A Tropical Cyclone Formation Alert was issued at 230430Z September. The first warning was issued at 230900Z September for a 30 kt tropical depression. TS Cam (25W) began tracking northeastward under the steering flow of low to mid-level ridging to the east and slowly intensified attaining tropical storm intensity at 240600Z September and a maximum intensity of 40 knots at 241200Z September.

After TS Cam (25W) reached 22N, it abruptly turned west-northwestward in response to increased ridging to the north and consequently made landfall over Hong Kong at 260130Z as a 20 kt system. JTWC issued the 11th and final warning at 252100Z September as the system tracked inland and dissipated.

News reports indicated TS Cam (25W) was responsible for 15 injuries and the disruption of utilities and transportation services in and around Hong Kong.



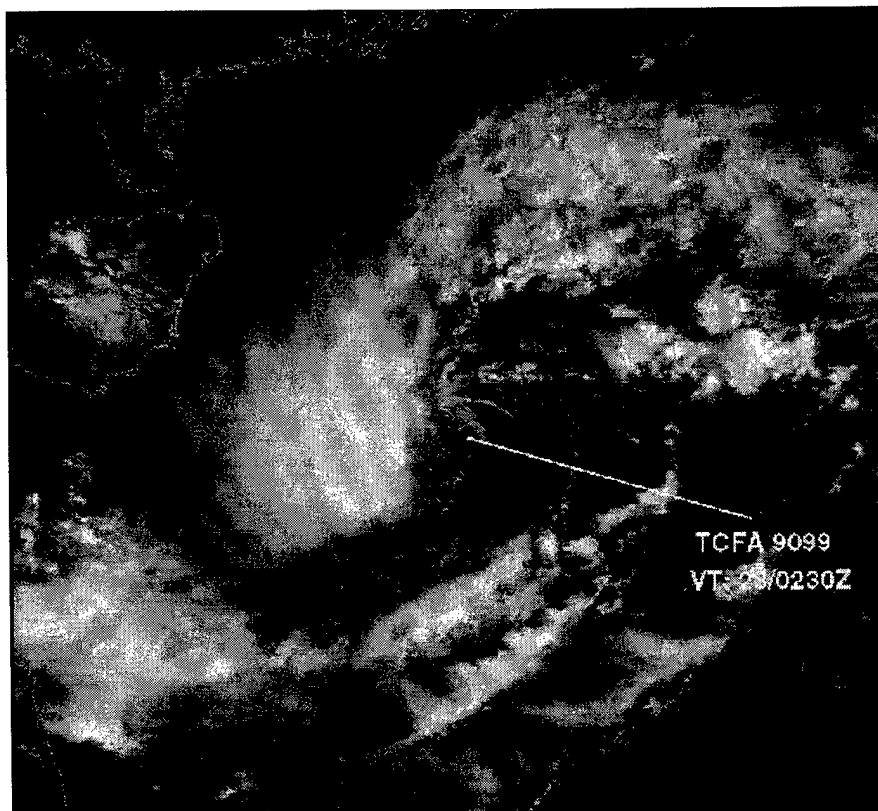


Figure 1-25-1. While a TCFA, this 230230Z September visible image reveals an exposed low level circulation center (LLCC) just east of convection. The convection built over the LLCC and the first warning on TS Cam (25W) was issued at 230900Z September.

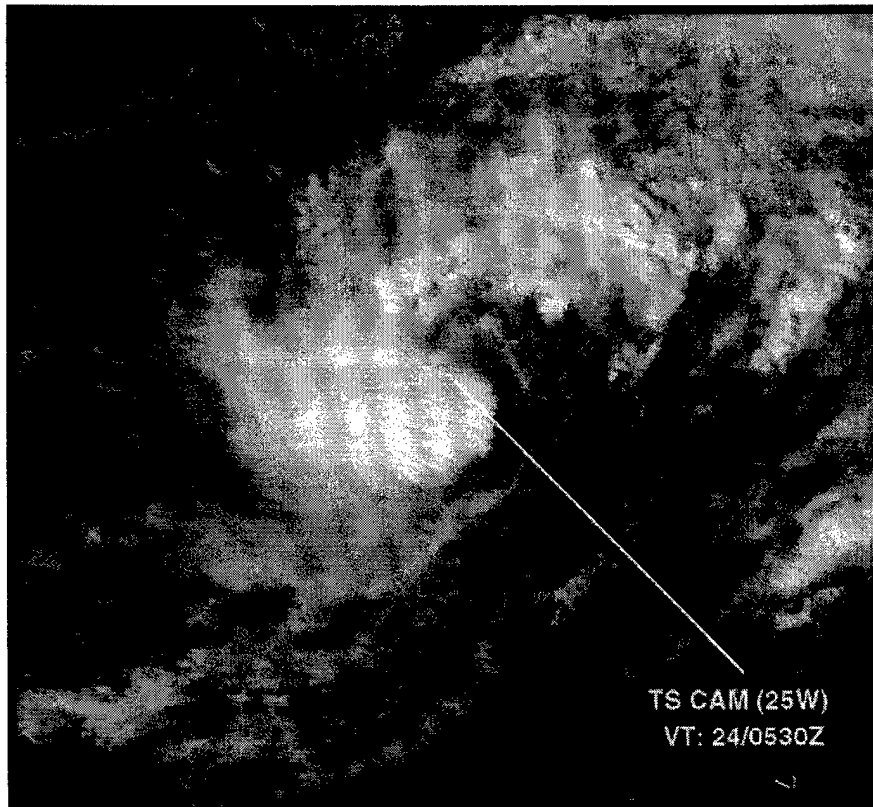


Figure 1-25-2. 240530Z September visible image of TS Cam (25W) at 35 kt intensity. This image reveals a partially exposed low level circulation center just north of the primary convection. Hong Kong lies just to the northwest.

## Typhoon Dan (26W)

Typhoon (TY) Dan (26W) developed over the Philippine Sea about 400 nm east of Luzon and reached a peak intensity of 110 kt before brushing the Northern Luzon coast at 050000Z October. TY Dan then moved over the South China Sea and weakened to 80 kt as it entered an increased vertical wind shear environment, then slightly re-intensified, as it approached China making landfall at 090200Z October near Xiamen (Amoy), China. News reports stated TY Dan left a swath of damage and fatalities from Luzon to China.

JTWC issued a Tropical Cyclone Formation Alert at 020230Z October. A Special Sensor Microwave Imager (SSM/I) pass depicted deep convection building over the low-level circulation center (LLCC) from the south. The first warning for TY Dan was issued at 021500Z October as a 25 kt tropical depression. TY Dan initially moved west-northwestward at 8 to 12 kt under the steering influence of the subtropical ridge centered over Japan.

TY Dan (26W) intensified to 110 kt before moving over the northern tip of Luzon. TY Dan decreased to 80 kt as it tracked west into the South China Sea. TY Dan then turned northward as a major shortwave trough moved over the coast of China. The system slowed to 5 to 7 kt and re-intensified to 90 kt as it tracked northward into China. At 100600Z October TY Dan began to weaken and take on extra-tropical characteristics as it moved over the Fujian province. On 101800Z October, TY Dan decreased to 20 kt before becoming absorbed within a frontal system moving over the Yellow Sea. JTWC issued the 35th and final warning at 110300Z October as the cyclone dissipated over the Yellow Sea.

A 7 October AP news report stated TY Dan (26W) produced heavy rains, damaged hundreds of houses and killed at least one person on Luzon, Philippine Islands. According to USA Today, TY Dan killed 30 people and caused \$240 million in damage as it battered China's Fujian province. Reports indicated that TY Dan was the worst tropical cyclone to hit the city of Xiamen in 46 years, killing five people and injuring more than 100 people. Collapsing buildings and walls killed seven people in Zhangzhou. Eighteen people were killed in the nearby city of Quanzhou.

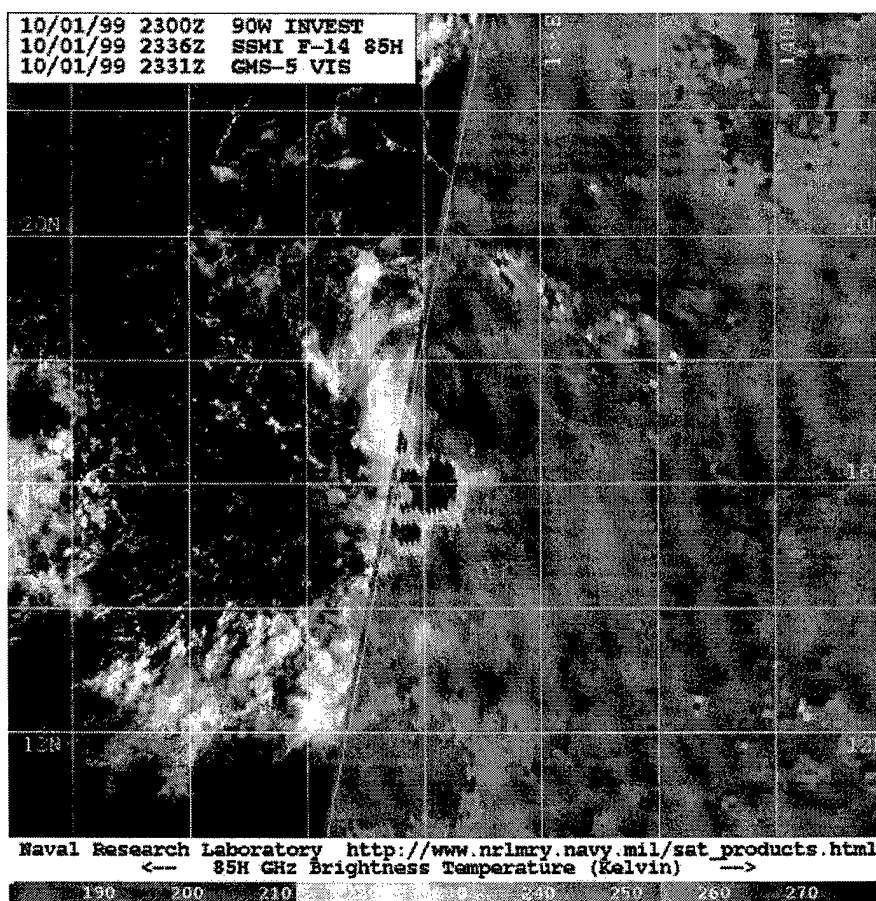


Figure 1-26-1. A 012336Z October Special Sensor Microwave Imager (SSM/I) pass combined with a 012331Z October GMS-5 visible image depicting deep convection building in over the low-level circulation center of TY Dan (26W) from the south. A TCFA was valid at the time and intensity is 20 kt.

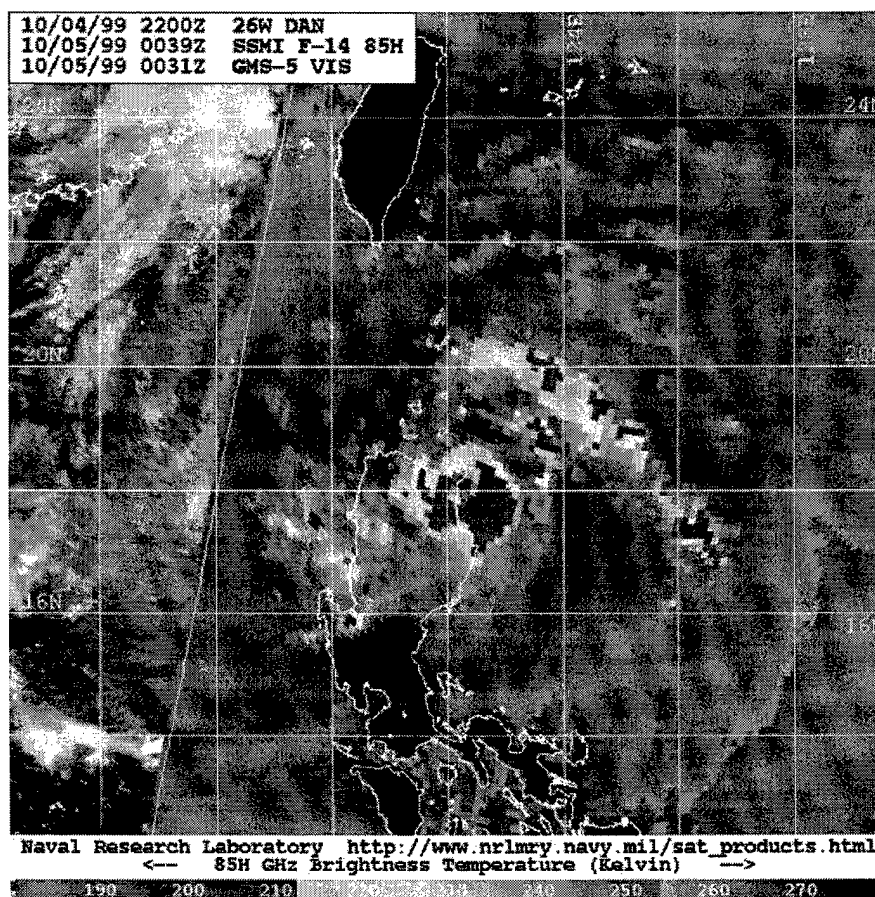


Figure 1-26-2. A 050039Z October Special Sensor Microwave Imager (SSM/I) pass depicting a 26 nm eye with a convective band situated to the northeast. TY Dan (26W) was at its maximum intensity of 110 kt.

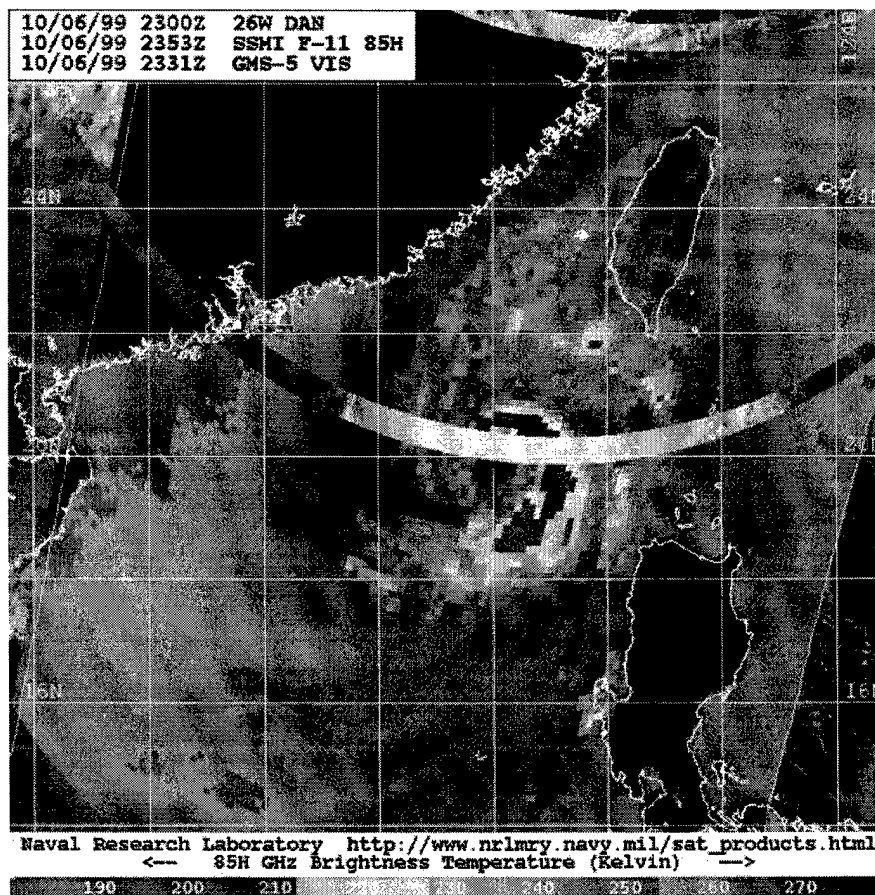


Figure 1-26-3. A 062352Z October Special Sensor Microwave Imager (SSM/I) pass depicting a significant banding feature of TY Dan (26W) extending south through north. Current intensity is 85 kt.



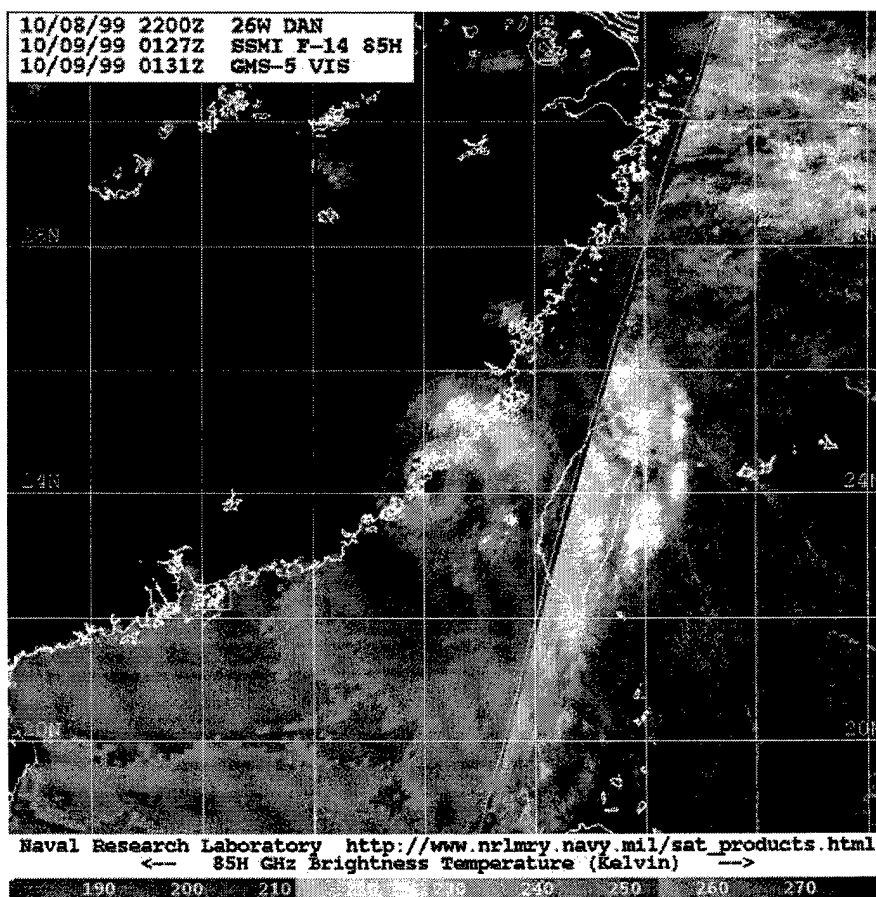


Figure 1-26-4. A 090127Z October Special Sensor Microwave Imager (SSM/I) pass depicting a 24 nm irregular eye and associated banding of TY Dan (26W) moving over the southeast coast of China. Current intensity is 90 kt.

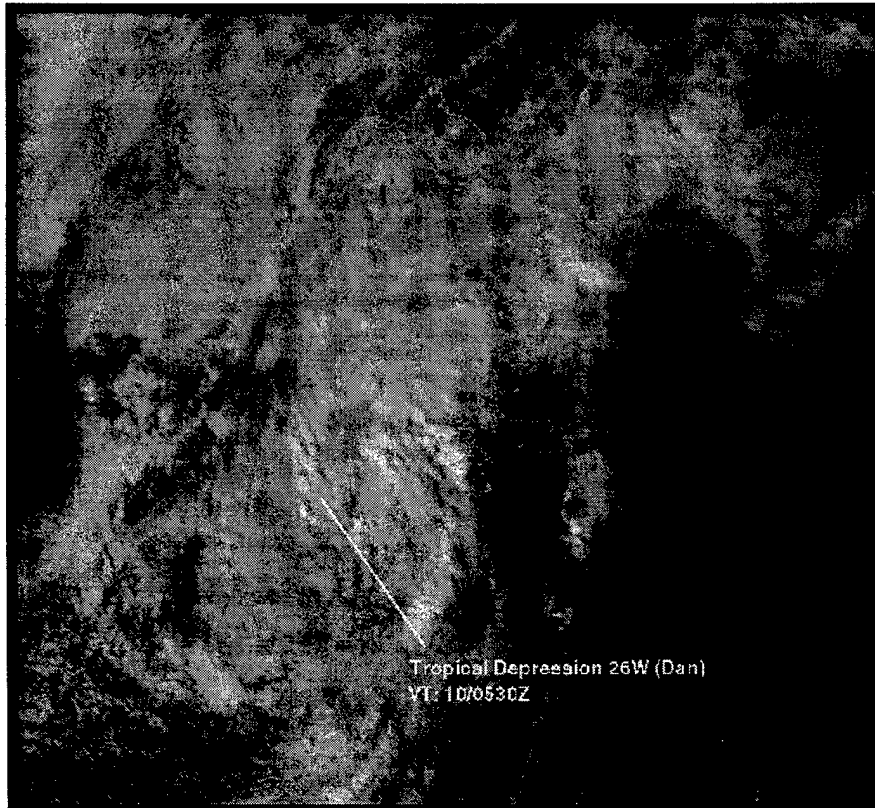


Figure 1-26-5. A 100530Z October GMS-5 visible satellite imagery shows TY Dan (26W) beginning to merge with a frontal system positioned just to the northwest. Current intensity is 25 kt.

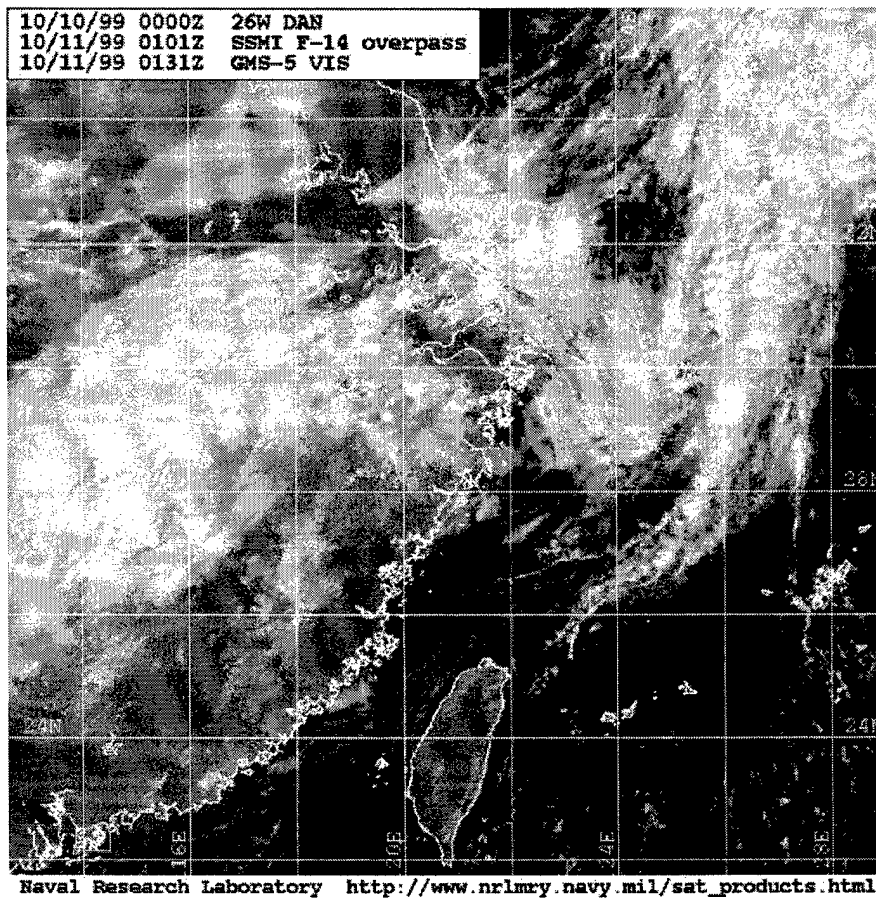
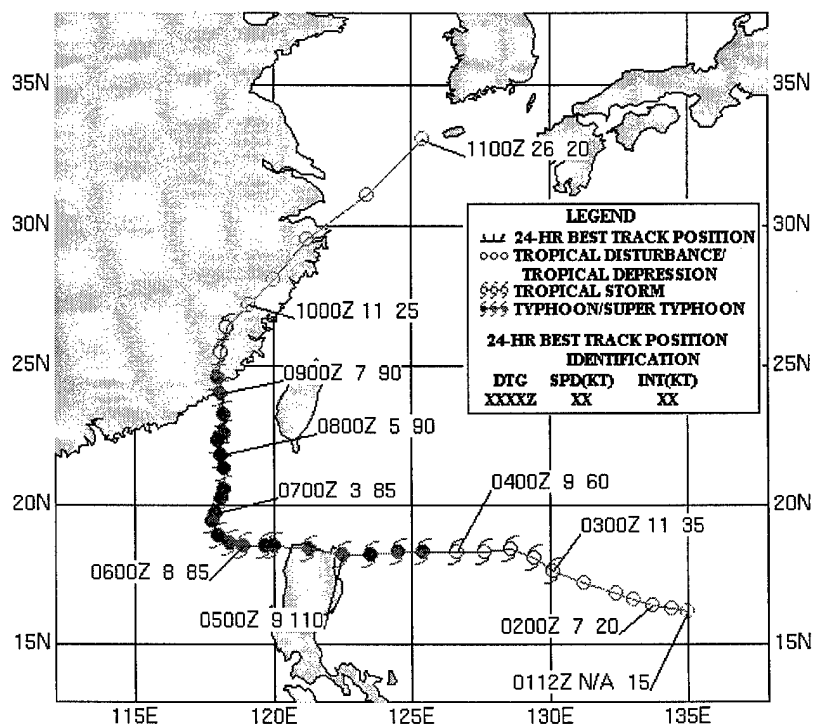


Figure 1-26-6. A 110131Z October GMS-5 visible satellite image shows TY Dan (26W) as an extratropical system now associated with a frontal boundary. Current intensity is 20 kt.



## Tropical Storm Eve (27W)

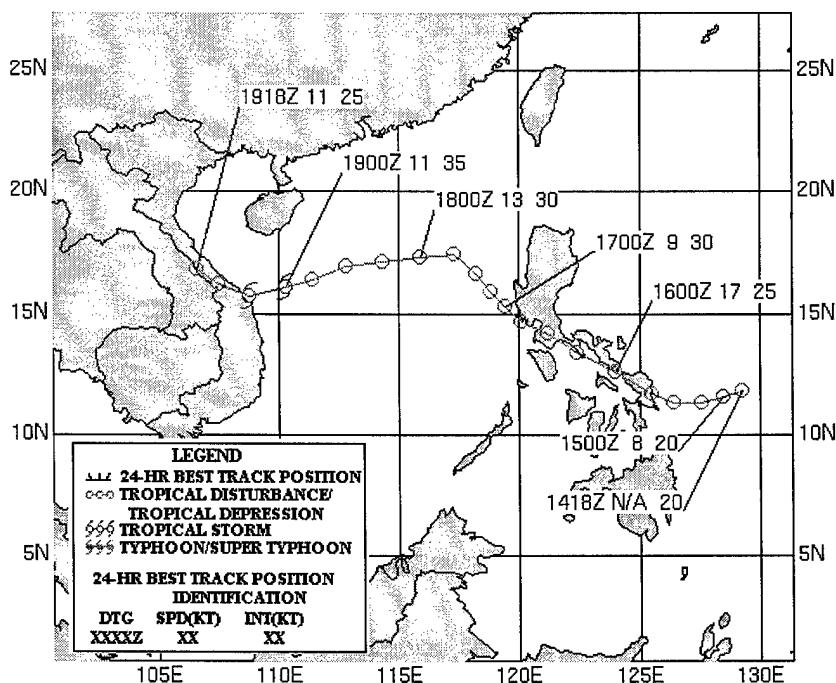
Tropical Storm (TS) Eve (27W) developed over the Philippine Sea and tracked northwestward over Samar and Luzon islands. The cyclone intensified, peaking at 35 kt, over the South China Sea and made landfall on 100600Z October southeast of Da Nang, Vietnam as a 35 kt tropical storm.

TS Eve (27W) was initially detected northeast of Mindanao as a poorly defined low level circulation center with disorganized convection. As organization increased, a TCFA was issued at 150230Z October followed by the first warning at 150900Z October with a 25 kt intensity.

TS Eve (27W) tracked northwestward across the Philippine Islands as a tropical depression. After the cyclone moved over the South China Sea, it turned toward the west, then west-southwest as low to mid-level ridging built north of the system from southeastern China. During this period, the cyclone also intensified into a minimal tropical storm reaching a maximum intensity of 35 kt at 190000Z October.

TS Eve (27W) made landfall at 190600Z October, 60 nm southeast of Da Nang, Vietnam, as a minimal tropical storm (35 kt) and the cyclone quickly dissipated over land. JTWC issued the 18th and final warning at 191500Z October as it moved inland and dissipated.

TS Eve's (27W) torrential rains were the first in a series of heavy rain events that lasted for 2-3 weeks and resulted in over 590 fatalities and \$235M in flood damage across Vietnam (Dartmouth Flood Observatory 1999).



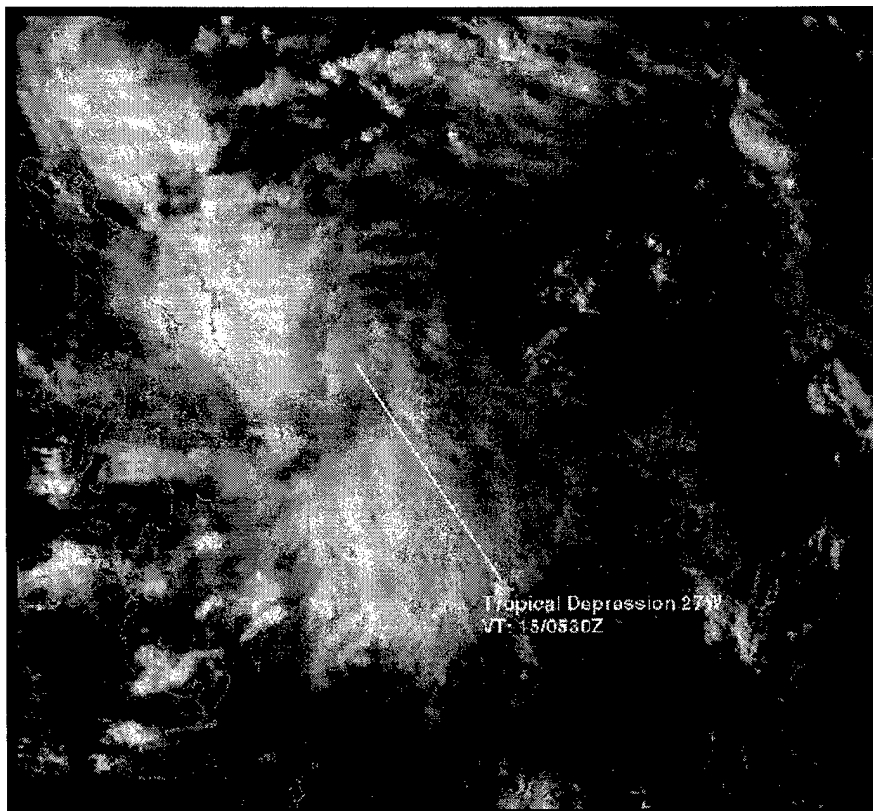


Figure 1-27-1. A visual image of TS Eve (27W), northeast of Mindanao, at 150530Z October. This image reveals the low level circulation center flanked to the northwest and southeast by clusters of convection as the system began to slowly organize. TS Eve is at 25 kt intensity.

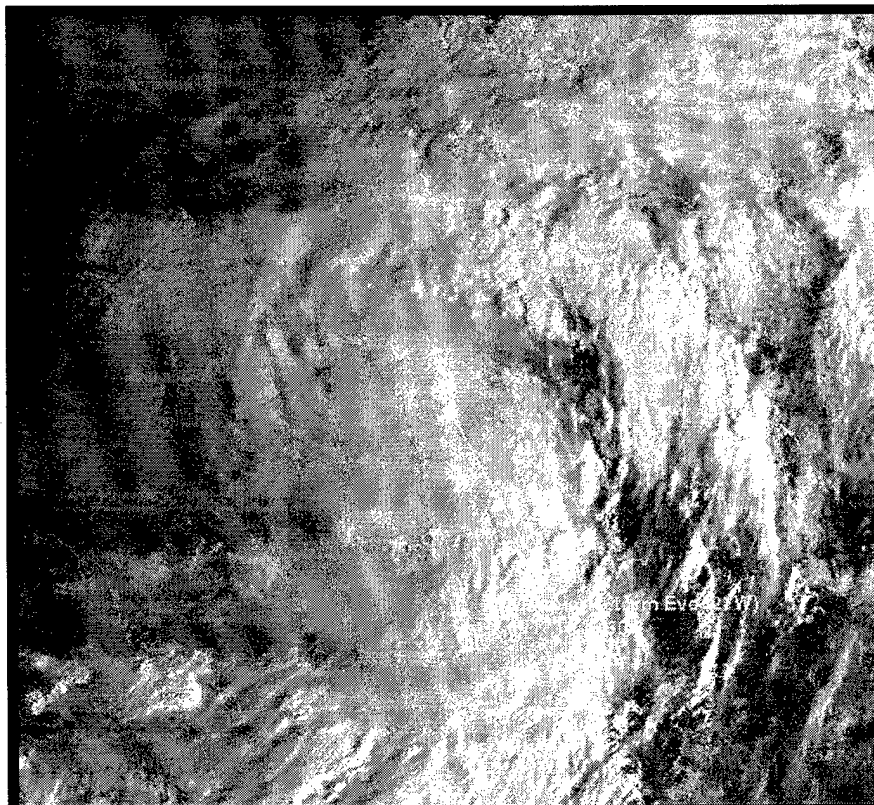


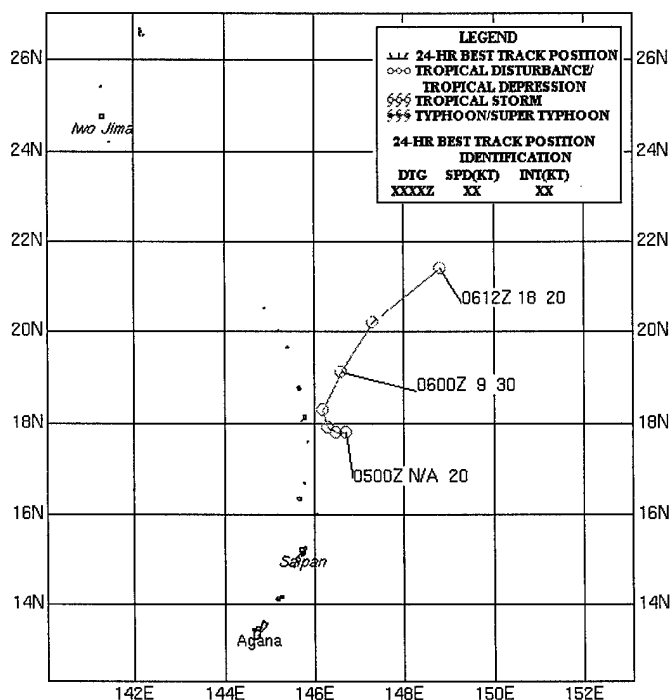
Figure 1-27-2. 182330Z October visible image of TS Eve (27W) six hours prior to landfall, just east of Vietnam. TS Eve had just reached tropical storm intensity and was tracking west-southwestward at 10-15 kt.

## Tropical Depression 28W

Tropical Depression (TD) 28W developed northeast of the Mariana Islands, 25 nm southeast of Agrihan, in early November. TD 28W formed on the tail-end of a shearline in a weakness of the subtropical ridge. TD 28W was a weak, short-lived late season tropical depression. TD 28W peaked as a 30 kt tropical depression on 051800Z November and dropped to a 20 kt disturbance 18 hours later.

JTWC first began tracking the tropical disturbance on 040600Z November and mentioned the disturbance on the Significant Tropical Weather Advisory (ABPW). TD 28W developed on the end of a shearline that was connected to a frontal boundary off of Japan. TD 28W was very difficult to locate and satellite positions were relocated several times. Initial forecast tracks had relocated it southwestward, but post analysis of imagery indicates it was actually located northeast of the relocation. After the relocation, TD 28W tracked along the shearline and turned north of the ridge, accelerated, and weakened while transitioning to an extratropical low.

TD 28W was a short-lived tropical depression that reached a 30 kt maximum intensity. JTWC issued the fourth and final warning on 061500Z November as the depression weakened and began extratropical transition.





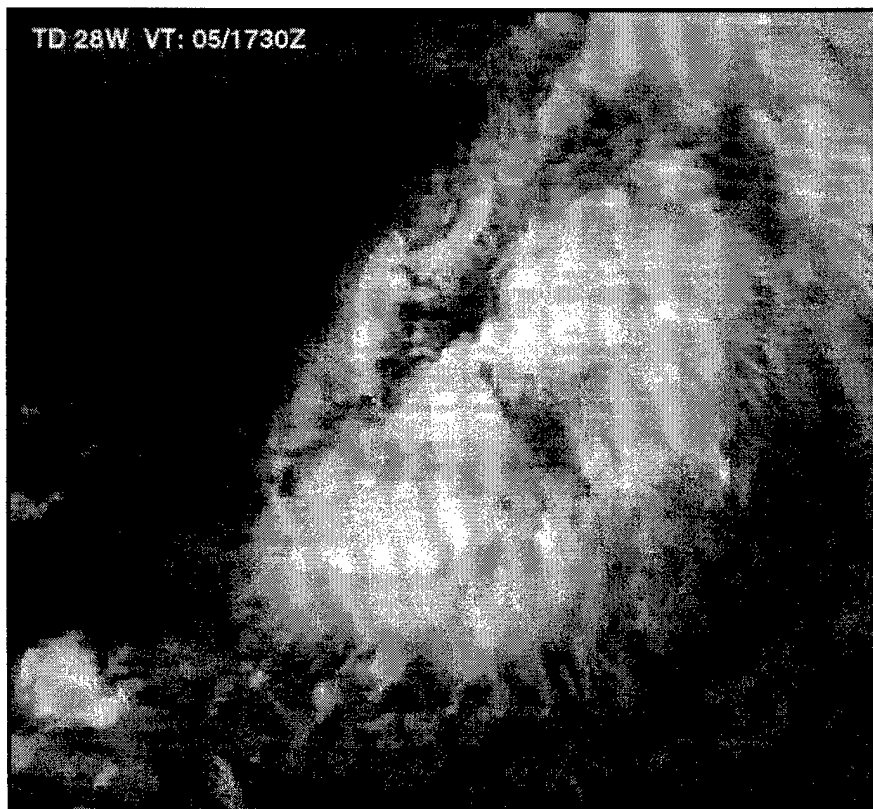


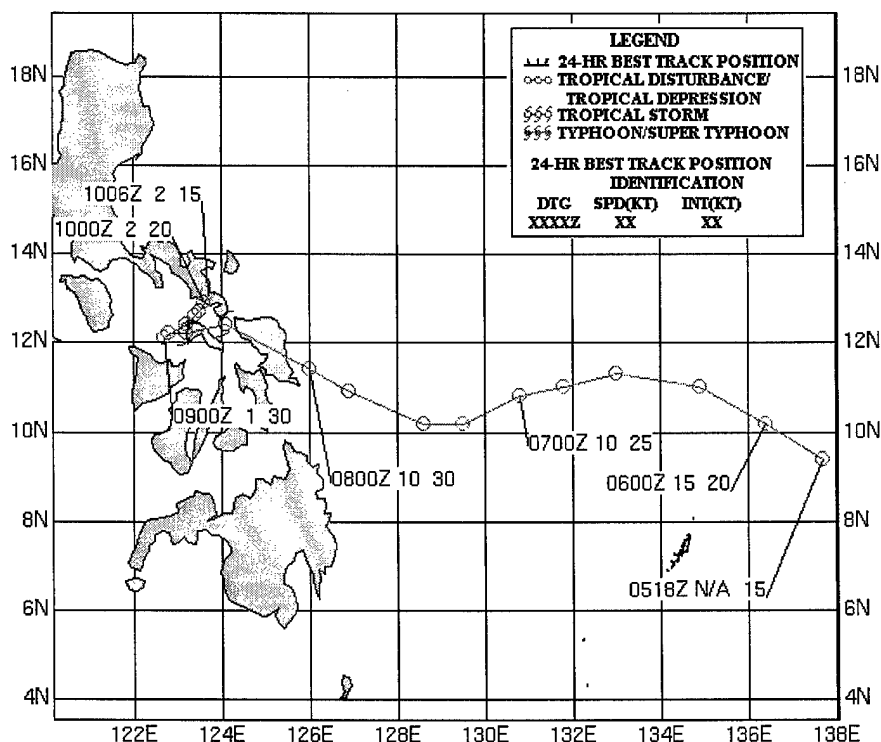
figure 1-28-1. 051730Z November GMS-5 infrared image of TD 28W at the initial warning. TD 28W was at its peak intensity of 30 kt.

## Tropical Storm Frankie (29W)

Tropical Storm (TS) Frankie (29W) developed over the Philippine Sea, northeast of Koror and tracked westward under the steering influence of the subtropical ridge to the north. The cyclone peaked at minimal tropical storm intensity as it moved into the central Philippines. Once over the Philippines, TS Frankie became quasi-stationary and dissipated within 36 hours.

Initially detected as a disturbance on 3 November, a TCFA was issued at 06130Z November. JTWC issued the first warning at 060900Z November as a 25 kt tropical depression.

TS Frankie (29W) moved quickly toward the west at 10 to 19 knots, turning northwestward as it reached tropical storm intensity on 080600Z November and maintained a 35 kt intensity as it moved into the central Philippine Islands. Although the main steering influence was the subtropical ridge to the north, a secondary ridge formed southeast of the cyclone as it approached the Philippines. Hence, when TS Frankie made landfall, the steering influence from the ridge to the north was offset by the steering influence from the ridge to the southeast, and TS Frankie became quasi-stationary. The cyclone then weakened due to interaction with land and increasing vertical wind shear. JTWC issued the 16th and final warning at 100300Z November as TS Frankie dissipated over the central Philippine Islands.



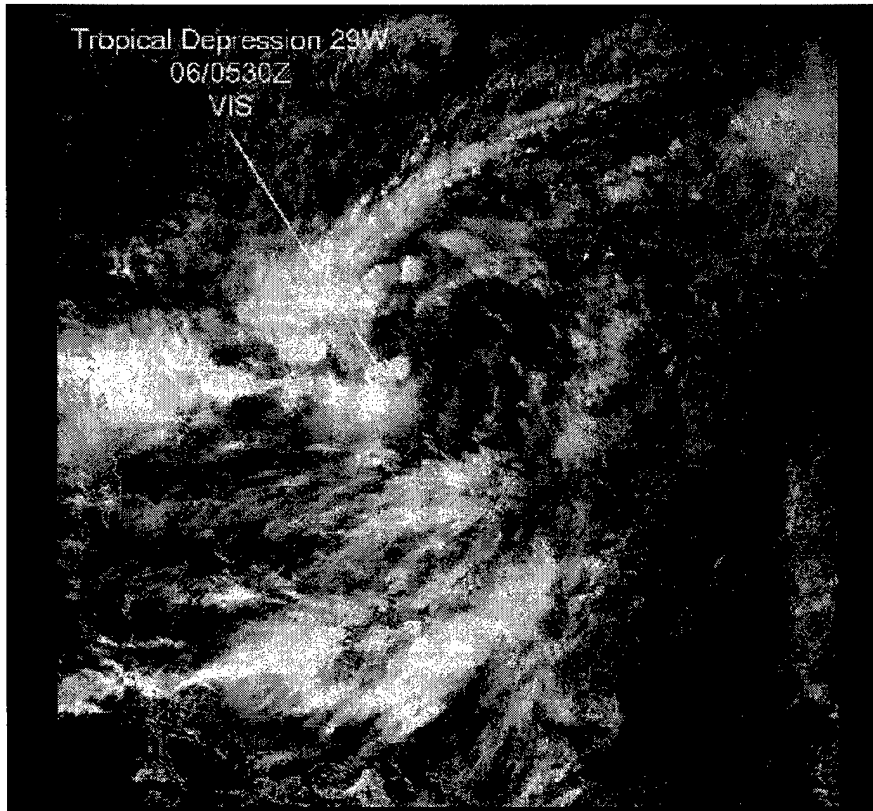


Figure 1-29-1. A visual image of TS Frankie (29W) at the initial warning at 060530Z November. This image reveals bands of deep convection beginning to develop and wrap toward the low level circulation center. Current intensity is 25kt.

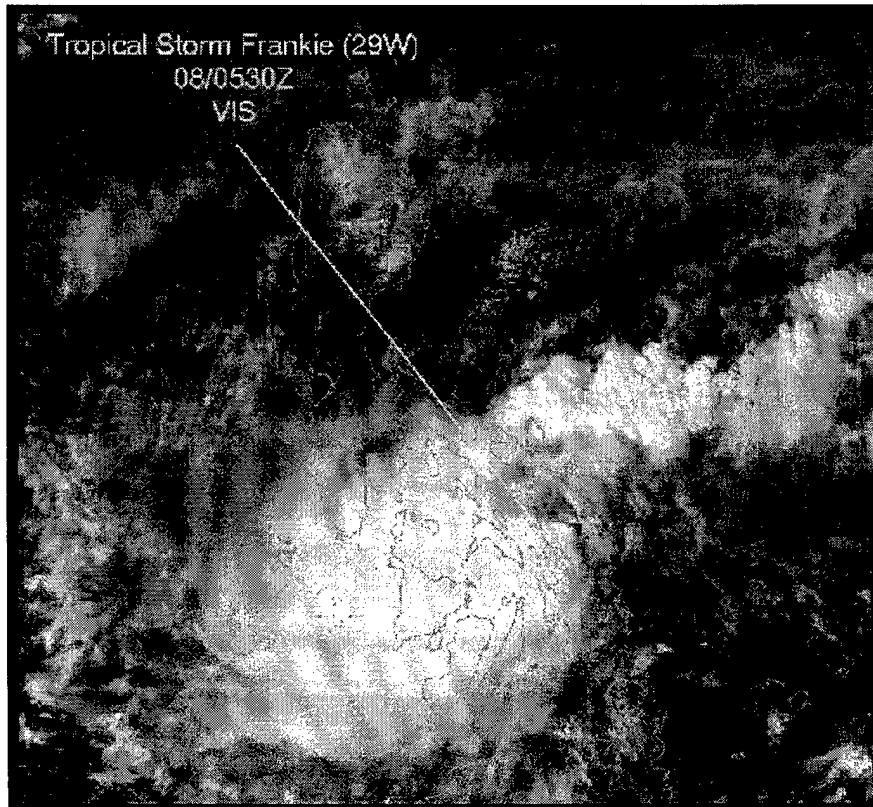


Figure 1-29-2. A visual image of TS Frankie (29W) at 080530Z November as the system began moving into the central Philippine Islands. The convection has been sheared to the west of the low level circulation center. The intensity was increased to 35 kt for the 080600Z November warning.

## Typhoon Gloria (30W)

Typhoon Gloria (30W) developed in the Philippine Sea, east of Samar Island, and slowly intensified into a weak tropical storm while moving northward. Typhoon Gloria eventually turned northeastward and began to accelerate. It passed just north of Iwo Jima and then rapidly intensified and reached minimal typhoon intensity just prior to extratropical transition.

A Tropical Cyclone Formation Alert was issued at 120700Z November, as a persistent area of convection at the tail-end of a shear line. The first warning was issued at 130900Z November as a 25 kt cyclone, with stronger gradient winds to the north associated with the northeast monsoon. The developing tropical depression was difficult to locate, and as development continued, a more northerly track quickly became evident.

Typhoon Gloria (30W) reached tropical storm intensity at 140900Z November while moving on a north-northwestward track. Meanwhile, a pronounced band of mid-latitude westerlies continued to slowly press toward the south and was expected to increase and inhibit intensification to moderate tropical storm intensity and eventually cause dissipation over water. Instead, the westerly flow actually caused or influenced continued intensification, acceleration, northeastward movement, and eventual extratropical transition.

As Typhoon Gloria (30W) began to move and accelerate under the increasingly northeastward steering flow, the cyclone fluctuated in overall appearance but maintained its intensity. As acceleration continued, the westerly flow appeared to extend deep into the mid levels preventing a quick shearing of the circulation. The cyclone intensified to typhoon intensity at 152100Z November for a very short period and reached a forward speed of 48 kt. Typhoon Gloria became fully extratropical and JTWC issued the 13th and final warning on 160900Z November.

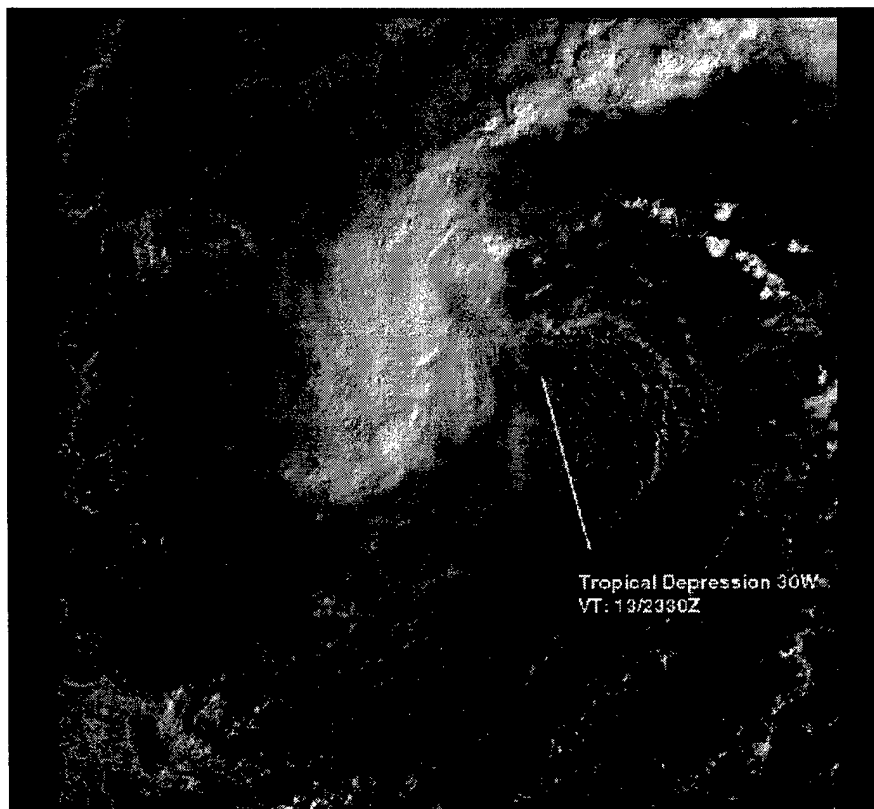


Figure 1-30-1. This visible image was taken 18 hours after the initial warning on TY Gloria (30W) at 132330Z November. A defined low-level circulation center (LLCC) remains completely exposed in the central Philippine Sea.

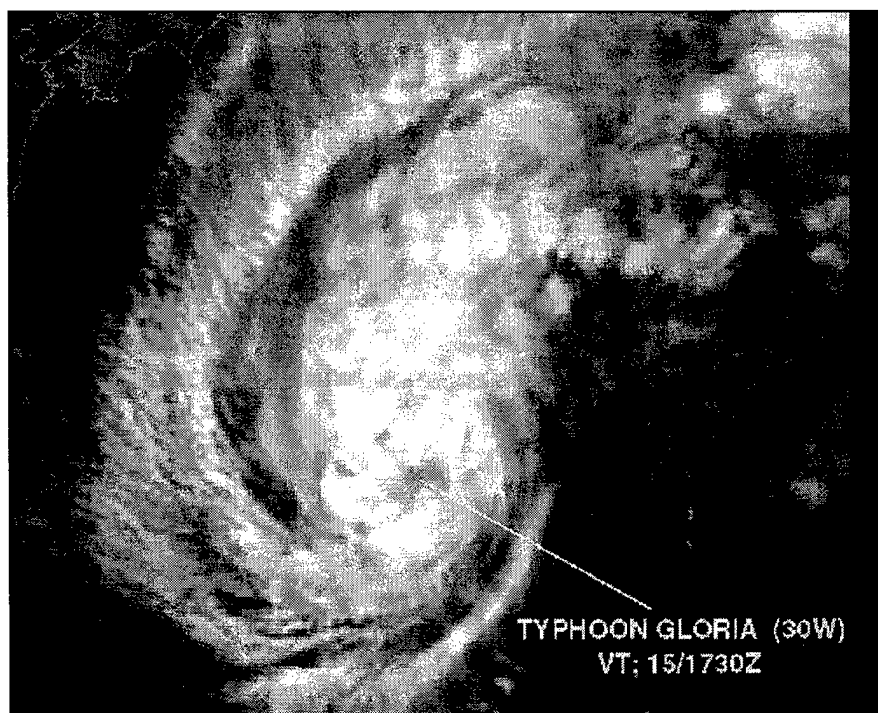
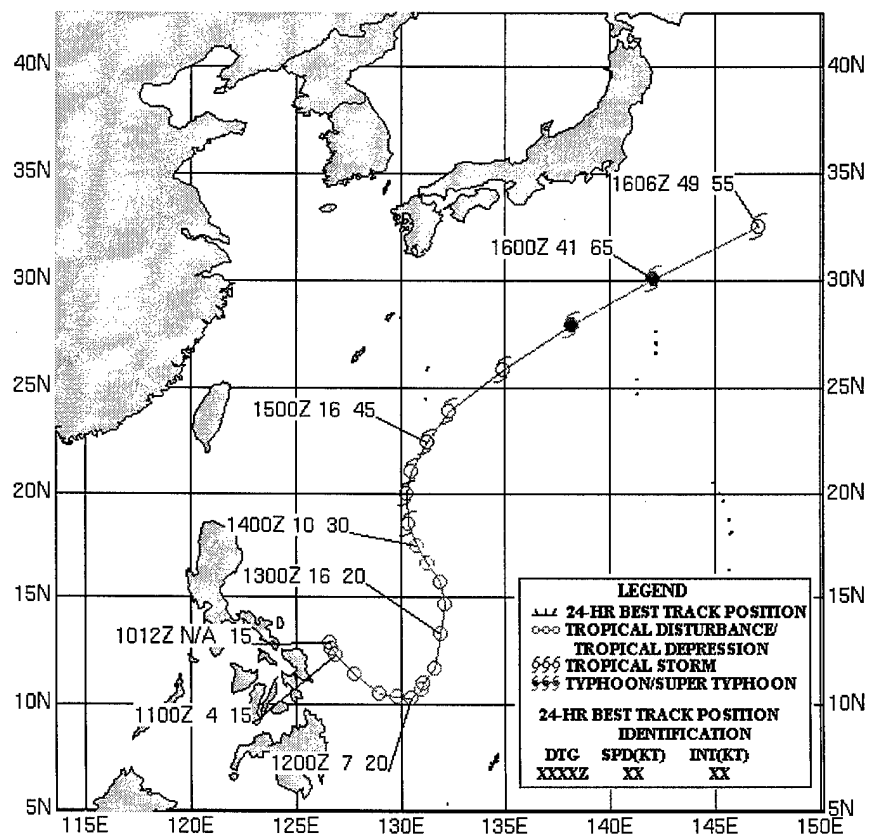


Figure 1-30-2. 151730Z November GMS-5 infrared image as Typhoon Gloria (30W) passed east of Iwo Jima. The short-term rapid intensification was just beginning as the system began extratropical transition and accelerated northeastward.





## Tropical Depression 31W

Tropical Depression (TD) 31W developed in the South China Sea near Palawan Island at the end of November and remained a relatively weak tropical cyclone while moving to the west. The disturbance reached a peak intensity of 30 kt before dissipating over land, northeast of Phuket, Thailand some six days after initial detection.

JTWC first noted this disturbance on the 280600Z November Significant Tropical Weather Advisory (ABPW). By 302230Z November, the suspect area had intensified and organized, thus, a Tropical Cyclone Formation Alert was issued. The first warning on TD 31W was issued about four hours later on 010300Z December.

TD 31W formed within a moderate to high vertical wind shear environment in the South China Sea. The surface circulation formed within a region bounded by the northeasterly winds of the winter monsoon and cross-equatorial southwesterlies. A subtropical ridge to the north of the disturbance would remain the dominant steering influence. TD 31W was relocated on the sixth warning, positioning the disturbance approximately 200 nm southwest of the previous position. After the relocation, TD 31W tracked westward toward the Malay Peninsula. As the cyclone moved through the Gulf of Thailand, the Thai National Oil Company (PTTEP), Chevron, and Unocal provided additional weather observations. These observations were of significant assistance in determining the location, intensity, and movement of the cyclone during passage through this area.

JTWC issued the 13th and final warning at 040300Z December as TD 31W moved over the Malay Peninsula and weakened. Subsequently, JTWC continued to monitor the tropical cyclone remnants as it moved into the Andaman Sea for redevelopment, which did not occur.

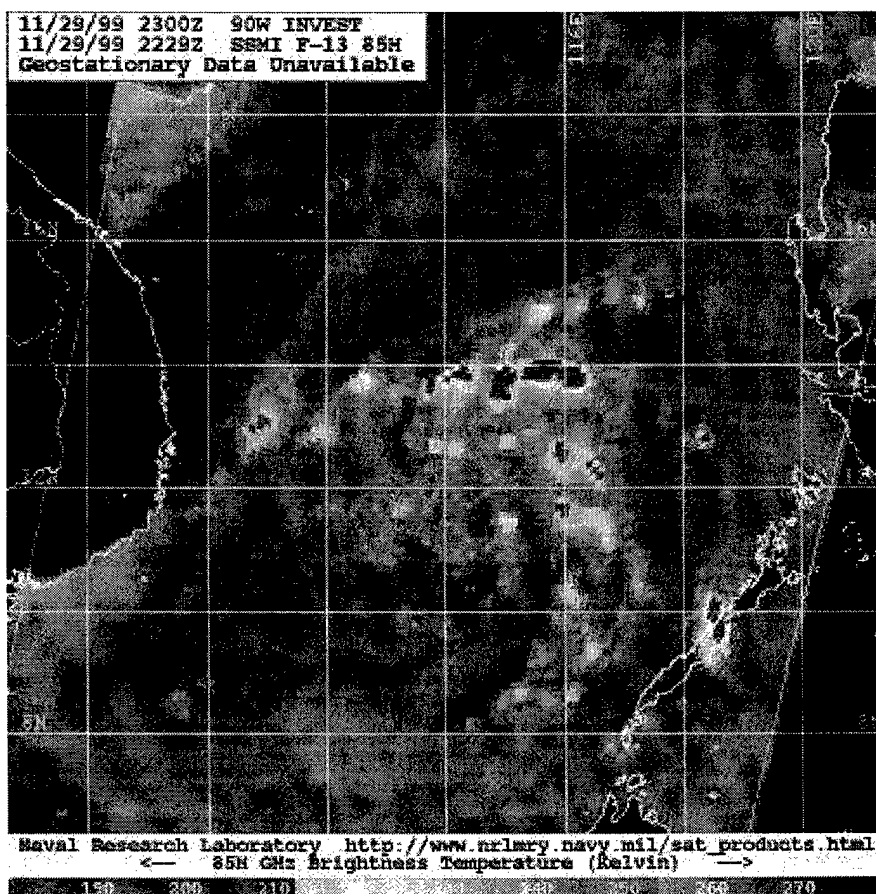


Figure 1-31-1. A Special Sensor Microwave Imager (SSM/I) image, taken at 292229Z November. A Tropical Cyclone Formation Alert was issued for this disturbance that would become Tropical Depression 31W. This image shows the increased organization and weak low-level circulation.

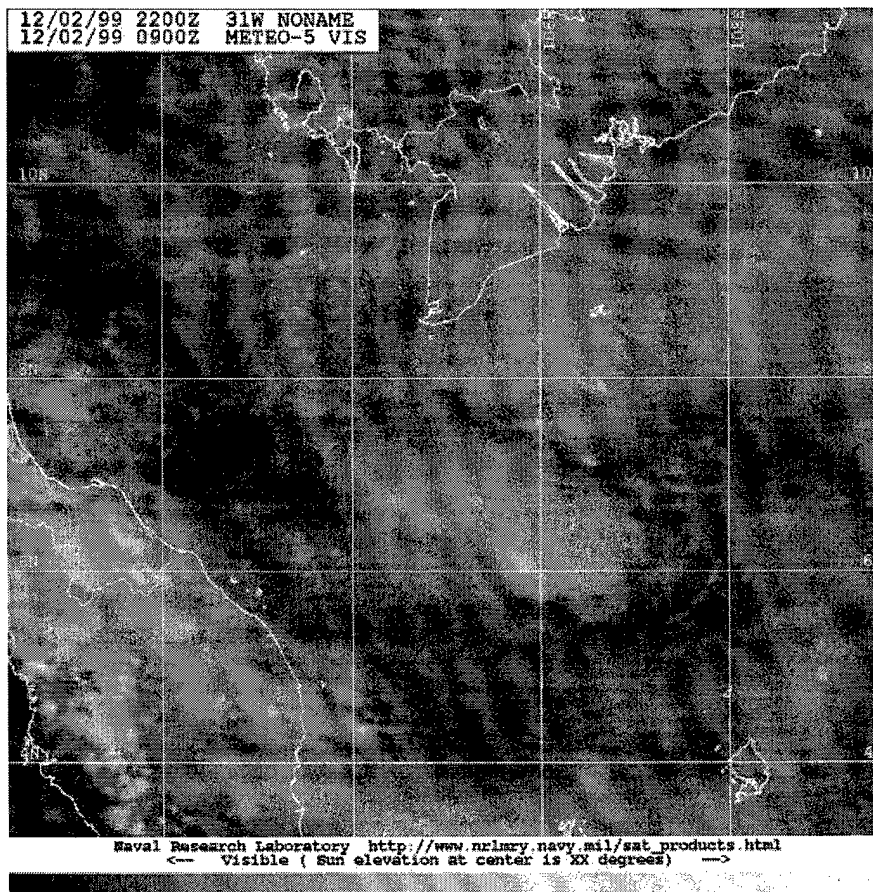
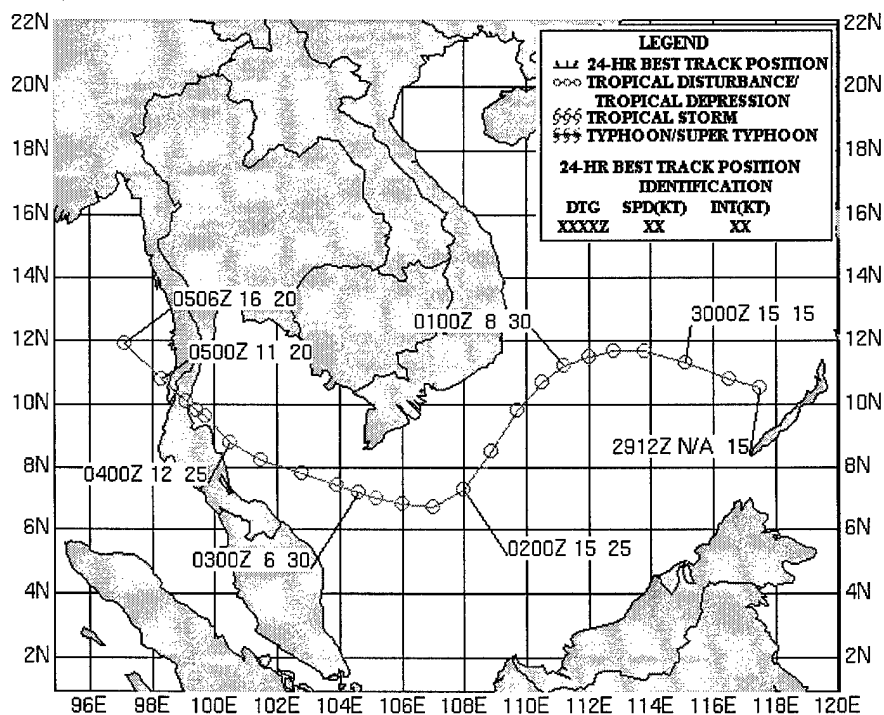


Figure 1-31-2. This visible Meteosat-5 image was taken at 020900Z December, shortly after Tropical Depression 31W was relocated 200 nm southwest. The weak low-level circulation is difficult to locate (near 6.8N 106.5E) and the moderate vertical wind shear environment is evident in the satellite imagery.



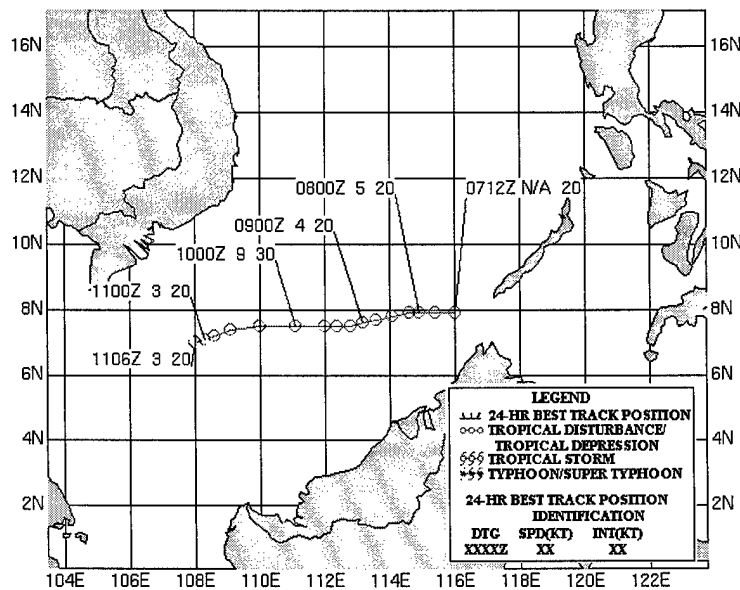
## Tropical Depression 32W

The second South China Sea tropical cyclone of 1999 formed in part due to wind shear produced by northeast monsoon flow and cross-equatorial westerly flow. Tropical Depression (TD) 32W developed between Palawan and Borneo then intensified slowly, moved westward, and dissipated over water south of Vietnam after 3 days.

TD 32W formed approximately 460 nm east-southeast of Cam Ranh Bay, Vietnam. JTWC issued the first warning on TD 32W at 092100Z December. By 100000Z December, the cyclone had attained a maximum intensity of 30 kt. Subsequently, vertical wind shear resulted in TD 32W becoming an exposed low-level circulation after 110000Z December.

TD 32W moved very slowly through the initial 48 hours, then began to accelerate westward to about 11 kt, before becoming vertically sheared, off the southern tip of Vietnam around 110000Z December. JTWC issued the sixth and final warning at 110300Z December.

This was the second of three very weak tropical depressions to form in early to mid December. JTWC relied heavily on scatterometry data from both the ERS-2 and the NASA QuickScatt for detection and positioning. Although the wind speeds had not been calibrated, the QuickScatt data was useful in providing an additional remotely sensed data set. Scatterometry coupled with SSM/I imagery and the judicious use of QuickScatt, allowed JTWC to better position and determine intensity of the three disorganized and weak tropical depressions.



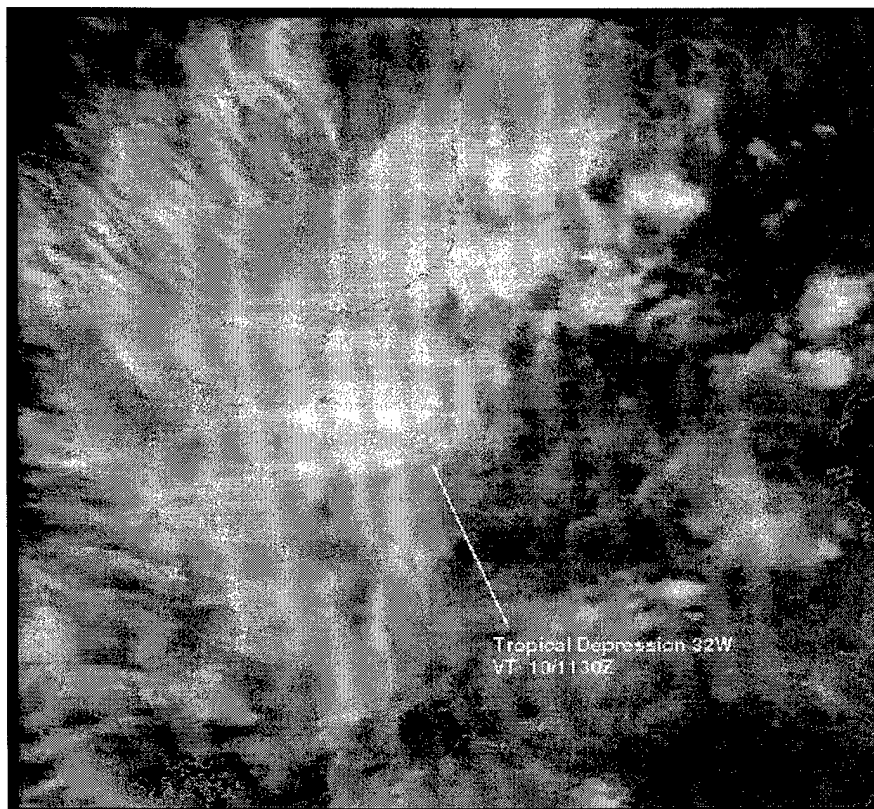


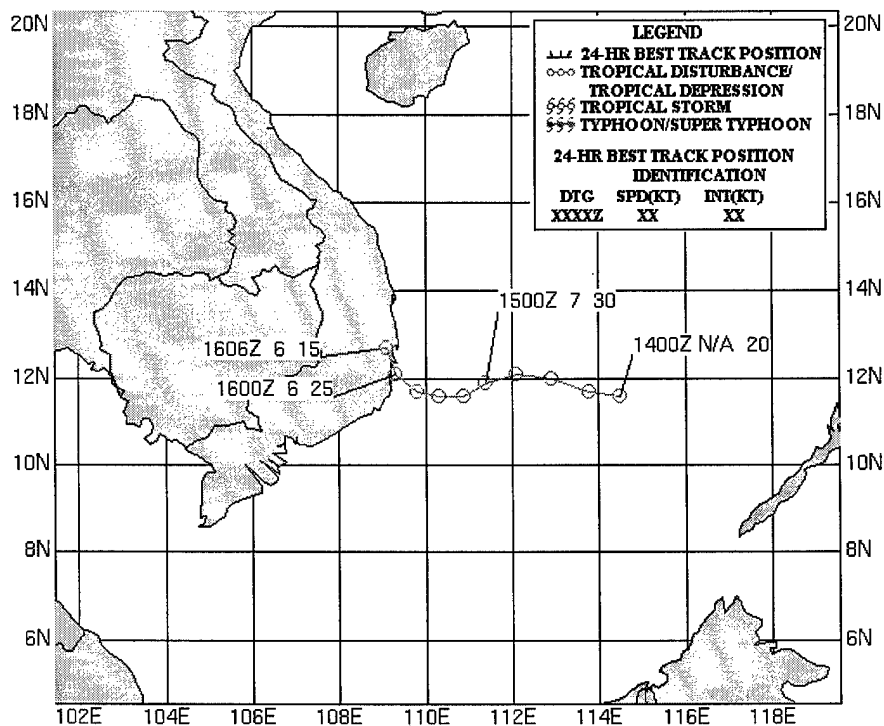
Figure 1-32-1. 101130Z December GMS-5 infrared satellite image of TD 32W at its peak intensity of 30 kt. The low-level circulation center (LLCC) is nearly indistinct in the image. This system once again showed the value of microwave satellites, passive and active, which can see through the upper-level clouds to pinpoint the LLCC.

## Tropical Depression (TD) 33W

Tropical Depression (TD) 33W was the final 1999 Northwest Pacific tropical cyclone. It formed in mid December within a persistent trough located across the Southern Philippine islands into the South China Sea. TD 33W intensified very slowly and reached a peak intensity of 30 kt, then moved westward and dissipated over central Vietnam two days later.

Tropical Depression (TD) 33W formed approximately 230 nm east of Cam Ranh Bay, Vietnam. JTWC first carried it as a suspect area on the 110600Z December ABPW bulletin, and issued the first warning at 141500Z December. By 141800Z December, the cyclone had attained a maximum intensity of 30 kt, and maintained this intensity for the next 24 hours. Throughout its lifetime TD 33W remained under a high vertical wind shear environment which hindered development. After 160000Z December, TD 33W encountered increased vertical wind shear that resulted in the low-level circulation center becoming fully exposed with the deep convection shearing northward. This increased shear and interaction with land led to the dissipation of TD 33W as it moved over Vietnam.

TD 33W made landfall at 160300Z December near Nha Trang, Vietnam as a 25 kt tropical depression. JTWC issued the 7th and final warning at 160300Z December as TD 33W dissipated over land.



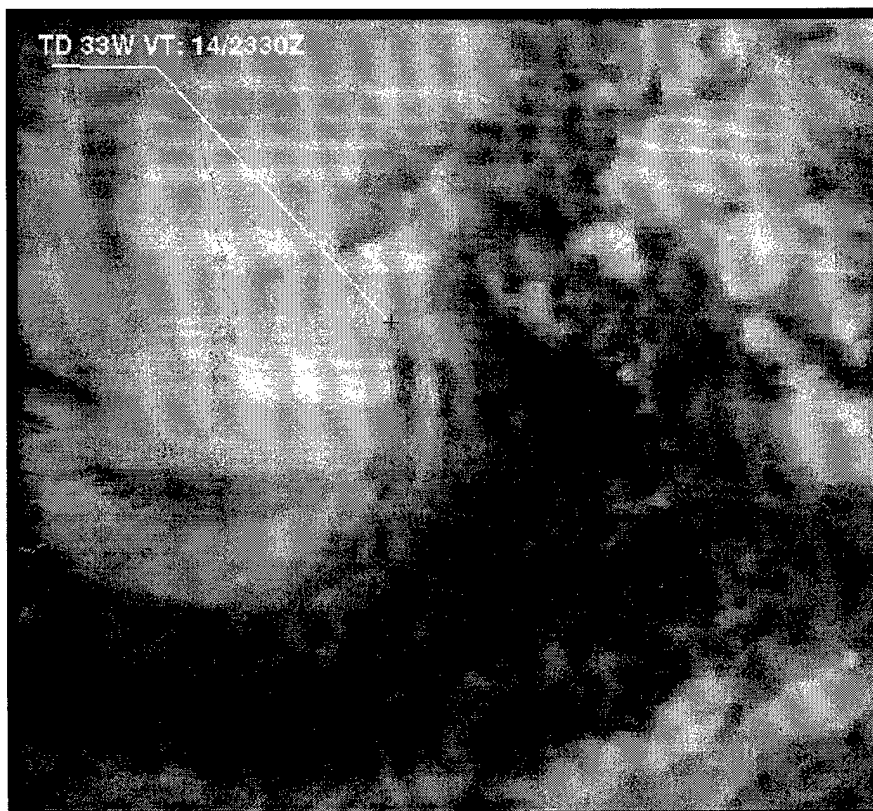


Figure 1-33-1. 142330Z December GMS-5 visible image of TD 33W as it approached the Vietnam coast. Current intensity is 30 kt.

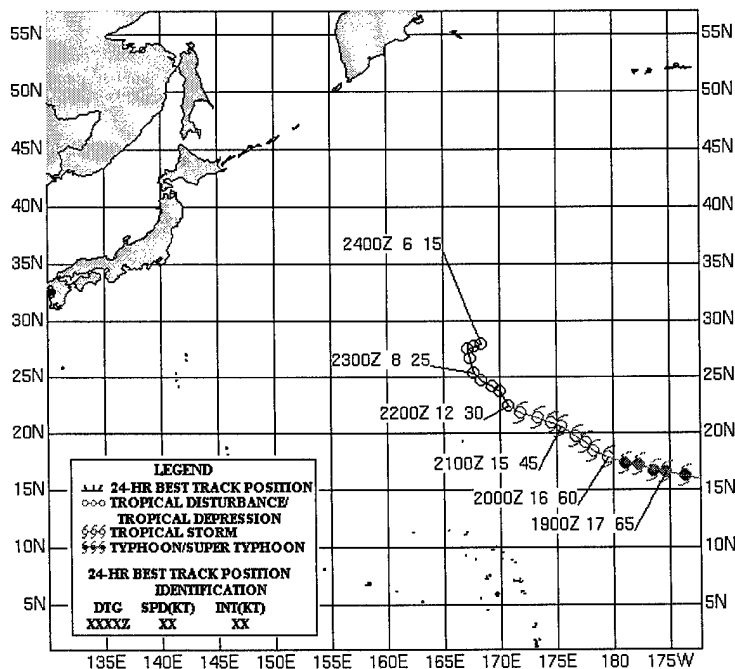


# Hurricane Dora (07E)

The disturbance that developed into Hurricane Dora (07E) formed in the eastern Pacific Ocean, west of Nicaragua, early in August 1999. The National Hurricane Center issued the first warning on Tropical Depression 07E at 060000Z after a ship report of 30 kt associated with the disturbance. Over a period of nearly three weeks this tropical cyclone would develop into an intense hurricane (120 kt) and travel more than five thousand miles across the Pacific Ocean before dissipating over open water.

After the first warning, this cyclone intensified for several days and developed a symmetric eye on 9 August. For over a week thereafter a strong mid-latitude anticyclone anchored over the central Pacific steered Hurricane Dora almost directly westward at an average speed of 14 knots. Hurricane Dora passed roughly 200 miles south of Hawaii island (Figure 1-07E-2). The forecast track and associated storm surge caused the evacuation of Johnston Atoll, however it passed 65 miles south of the atoll without causing significant damage.

Hurricane Dora crossed 180 degrees longitude and was downgraded to a tropical storm (50 kt) on Joint Typhoon Warning Center's first warning at 201500Z August. The system began gaining latitude and continued to weaken due to increasing vertical wind shear. JTWC issued the 70th and final warning at 230900Z August.



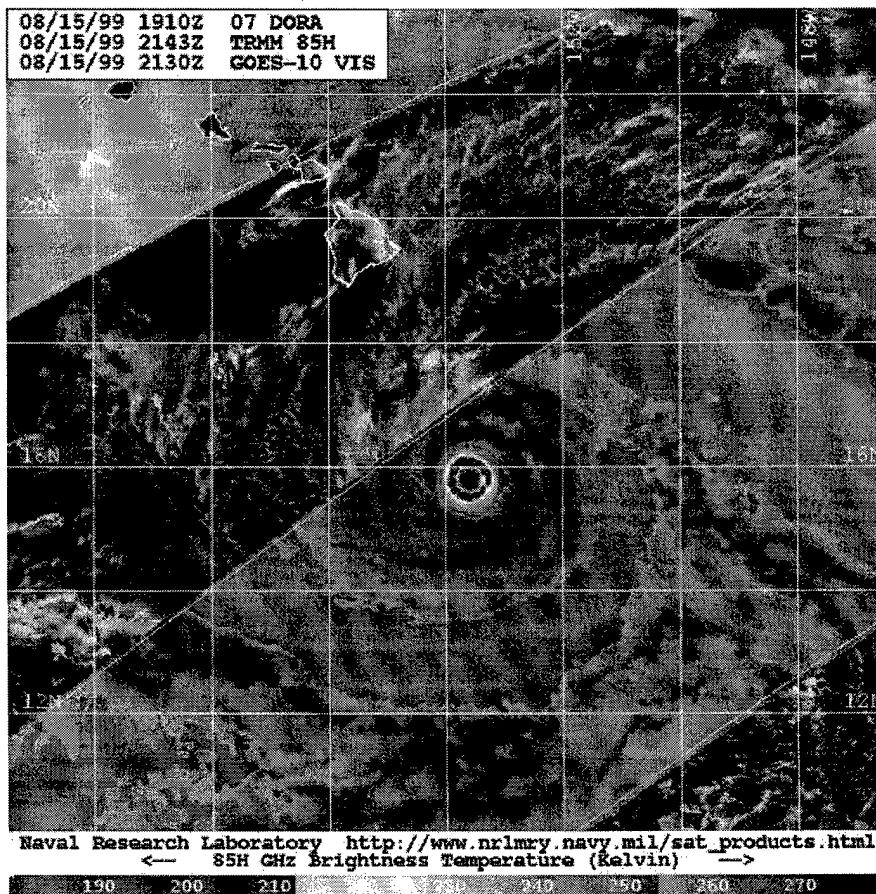


Figure 1-07E-1. 152143Z August Tropical Rainfall Measuring Mission (TRMM) microwave image overlaid on 152130Z August GOES- 10 visible satellite imagery created by the Naval Research Laboratory (NRL). Of note is the extremely intense eye-wall feature. Hurricane Dora passed south of the Island of Hawaii with a max intensity of 100 kt.

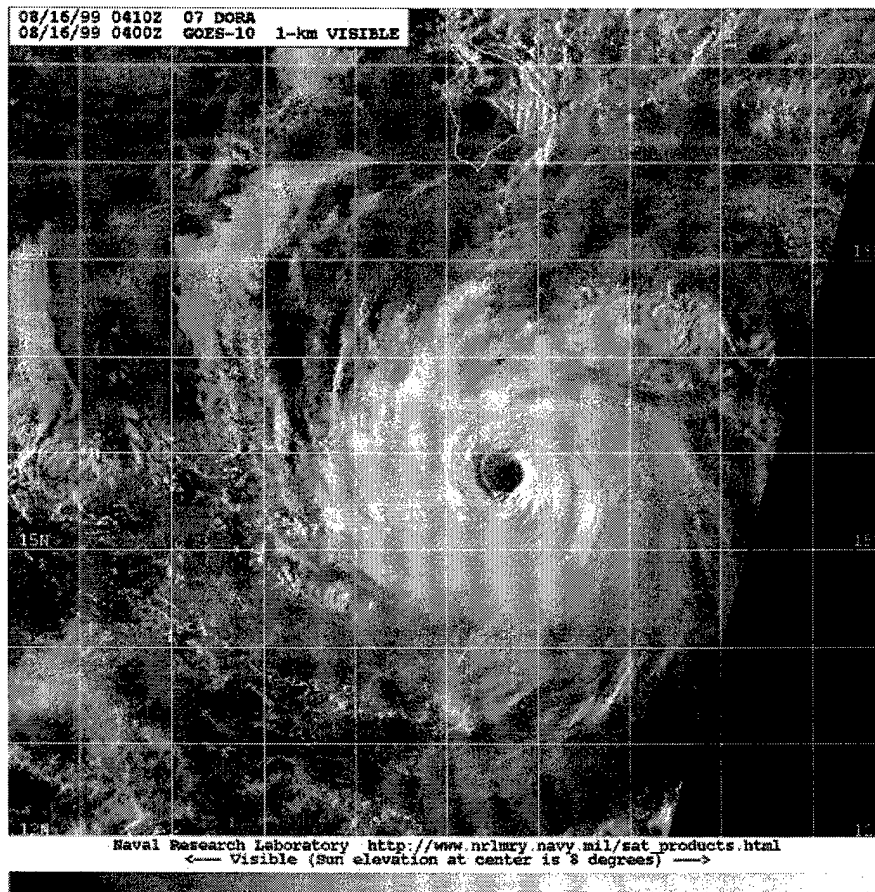


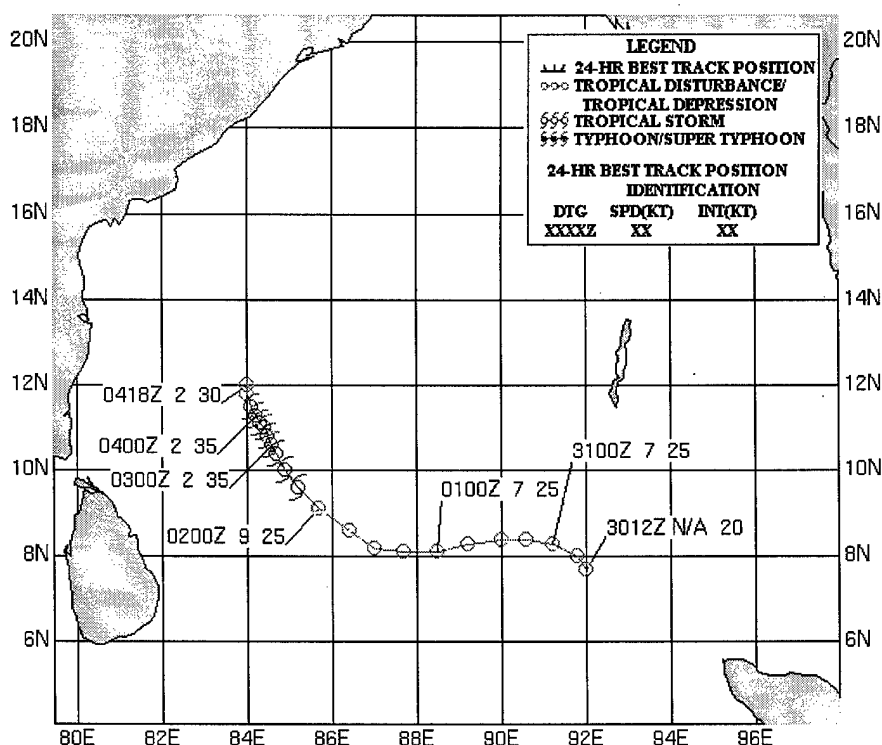
Figure 1-07E-2. 160400Z August GOES-10 visible satellite imagery showing the well-defined eye of Hurricane Dora as it passed south of the Island of Hawaii with an intensity of 100 kt. The system went on to pass 65 nm to the south of Johnston Atoll, but caused no significant damage.

# Tropical Cyclone 01B

The first 1999 North Indian Ocean tropical cyclone warned on by JTWC developed in the southeastern Bay of Bengal. It intensified slowly (max 40 kt), moving westward, then northwestward, and dissipated over water after six days.

The disturbance that became TC 01B was very slow to develop and was first mentioned in the ABIO on 291800Z February. As the convection slowly consolidated, three Tropical Cyclone Formation Alerts were issued from 31 January to 02 February. Tropical Cyclone (TC) 01B formed approximately 370 nm west of Phuket, Thailand and JTWC issued the first warning at 020900Z February as satellite imagery indicated the disturbance had intensified. By 030600Z February, the cyclone had reached a maximum intensity of 40 kt. Subsequently, vertical wind shear caused TC 01B to weaken with an exposed low level circulation becoming apparent after 031800Z February.

JTWC issued the sixth and final warning at 042100Z February.



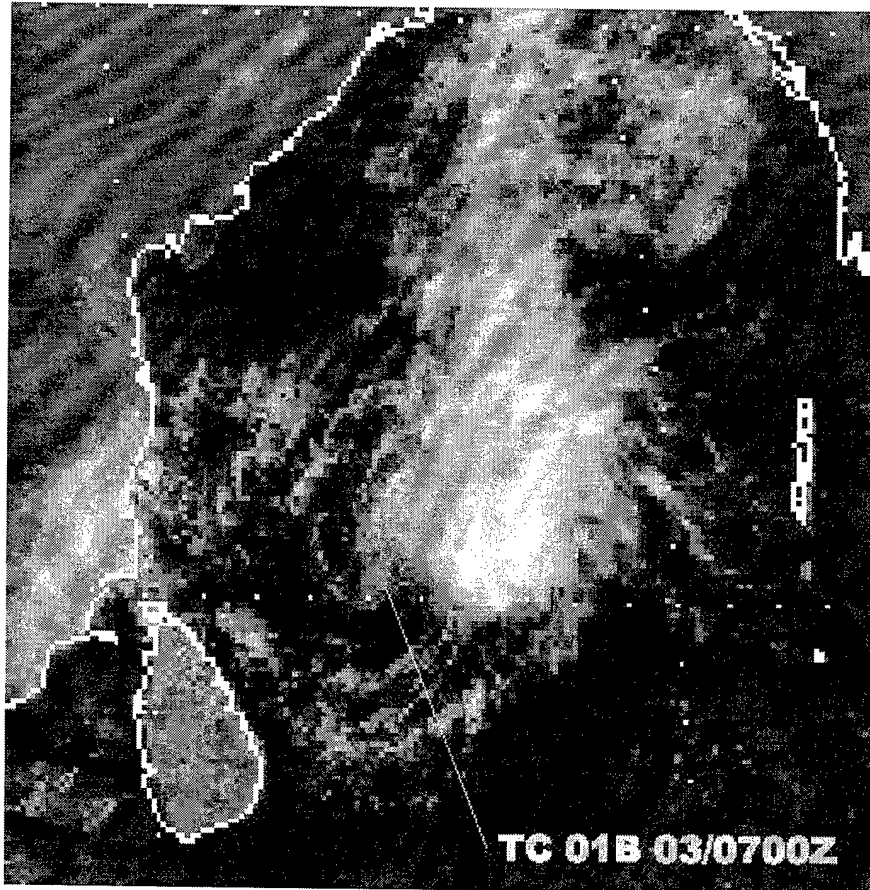


Figure 1-01B-1. This visible satellite imagery is indicative of the strong vertical wind shear environment in which TC 01B was situated as its maximum intensity. The Northeastern Monsoon coupled with strong southwesterly flow in the upper-levels is typical of this time of year, inhibiting tropical cyclone development. TC 01B was able to develop due to a weakness in the upper-level ridge.

## Tropical Cyclone 02A

Tropical Cyclone (TC) 02A (02A) was the only 1999 cyclone warned on by JTWC in the Arabian Sea. This cyclone developed in the Laccadive Sea in mid-May and initially moved northwest before turning toward the northeast. TC 02A reached a maximum intensity of 110 kt while on a northeast heading, just before making landfall approximately 97 nm southeast of Karachi at 200600Z May.

Tropical Cyclone 02A developed in the southwest monsoonal flow during mid-May. The area of convection was discussed on the ABIO for 2 weeks before the cyclone developed. During that time, strong convection would develop just before sunrise, at the diurnal convective maximum, and subsequently dissipate around sunset. A TCFA was issued on the system on 16 May at 0100Z.

The first warning was issued at 160900Z May with northwestward movement. TC 02A subsequently reached typhoon intensity on 170600Z May, after which a mid-latitude trough passing through the Middle East significantly weakened the subtropical ridge, allowing the system to recurve into Pakistan. By 190000Z May, the cyclone reached its maximum intensity of 110 kt, which it maintained through 200600Z May. TC 02A made landfall near Karachi, Pakistan as a 110 kt tropical cyclone. JTWC issued the 21st and final warning on 210900Z May as the system moved into the Indus River valley.

TC 02A was one of the most intense cyclones on record to develop in the Arabian Sea. Reports by Agence France-Presse indicated that 700 people were reported missing and presumed dead, including 11 paramilitary soldiers who were lost during a rescue attempt at sea. Total damage was estimated at \$6 million.

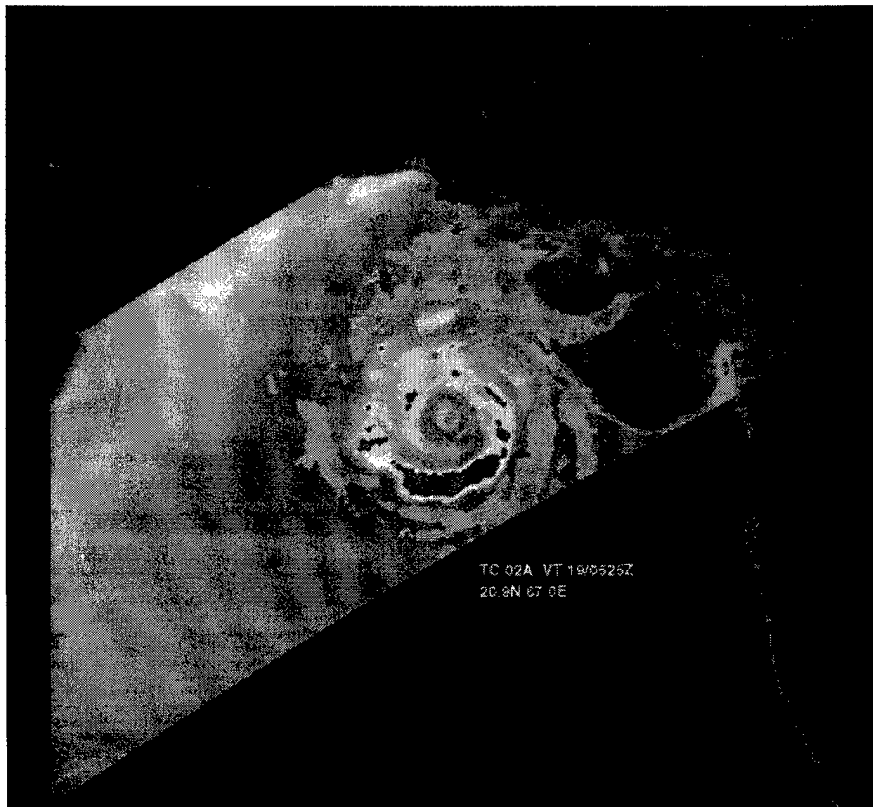
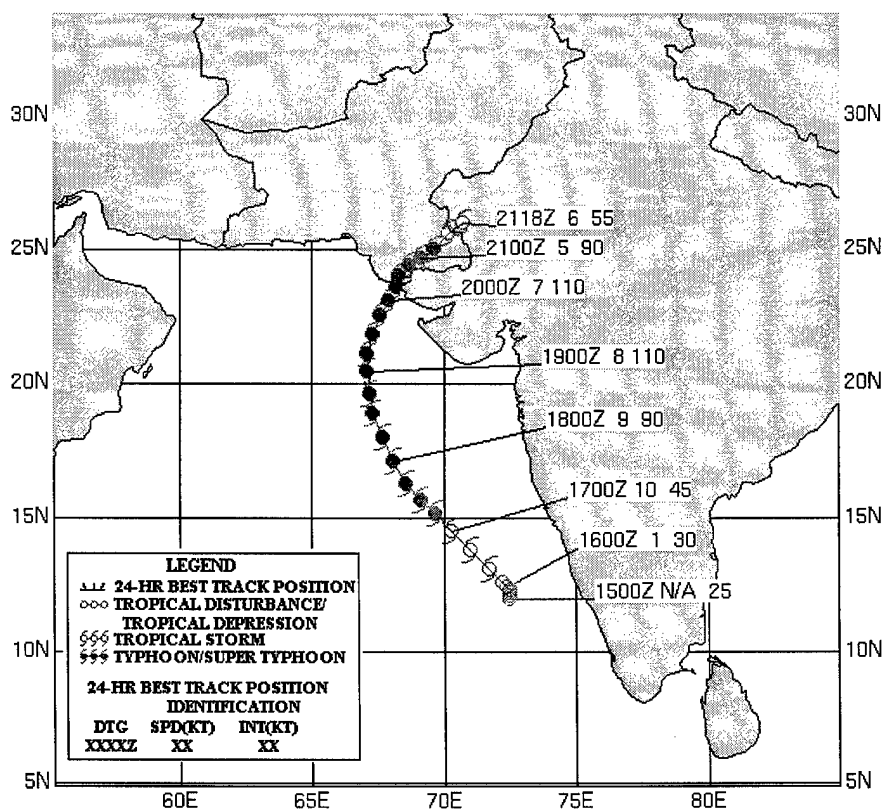


Figure 1-02A-1. 190525Z May SSM/I pass over TC 02A as it reached maximum intensity (110 kt) 235 nm south of Karachi. Of note in this image is the concentric eyewall. Continuing development served to weaken the inner eyewall, which was replaced by the outer, stronger feature.



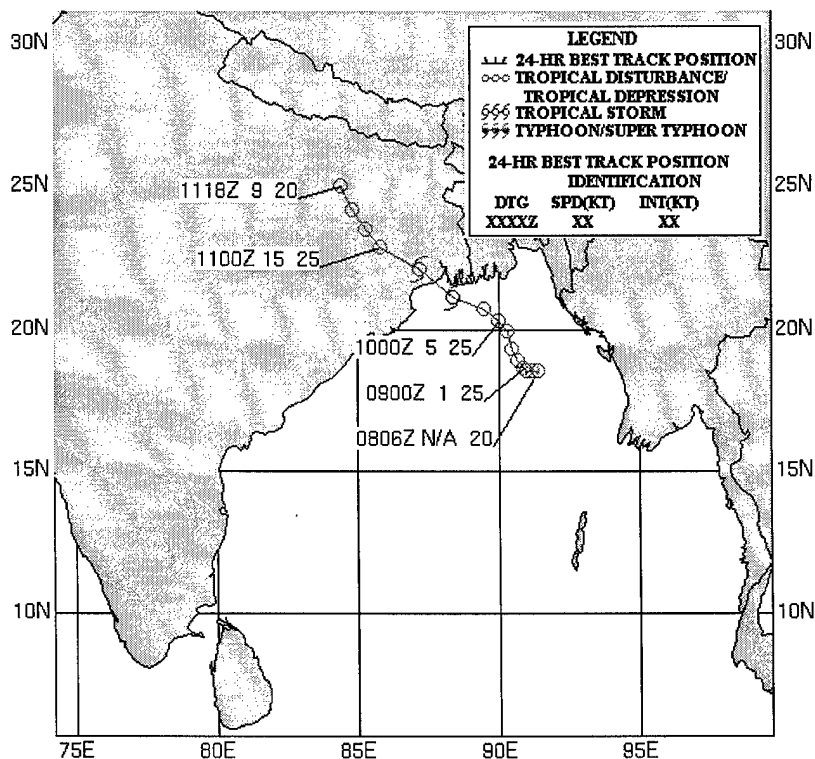


## Tropical Cyclone 03B

Tropical Cyclone (TC) 03B became the second 1999 Bay of Bengal tropical cyclone warned on by JTWC. TC 03B developed from a broad circulation over the northern Bay of Bengal, then tracked northwestward and peaked as a minimum tropical cyclone at 35 kt before dissipating over eastern India.

The area of convection that became Tropical Cyclone (TC) 03B formed approximately 235 nm south of Chittagong, Bangladesh. JTWC issued a Tropical Cyclone Formation Alert at 100830Z June, then issued the first warning on TC 03B at 101500Z June with a maximum intensity of 35 kt. The cyclone maintained its 35 kt intensity as it went ashore west of Calcutta, India. TC 03B then dissipated over land, due to frictional effects and vertical wind shear. JTWC issued the second and final warning at 110300Z June.

The primary significance of this system was it initially was associated with a mid-level circulation over land, which migrated over the Bay of Bengal, developed enough convection and intensity to become a 35 kt tropical cyclone and subsequently moved back over land.



SATELLITE: f14 1999 06 10 1437Z 85 GHZ H (Brightness Temperature)  
WARNING: INVEST (90B) 990610 1500 21.0N 87.0E  
NRL Monterey Code 7541

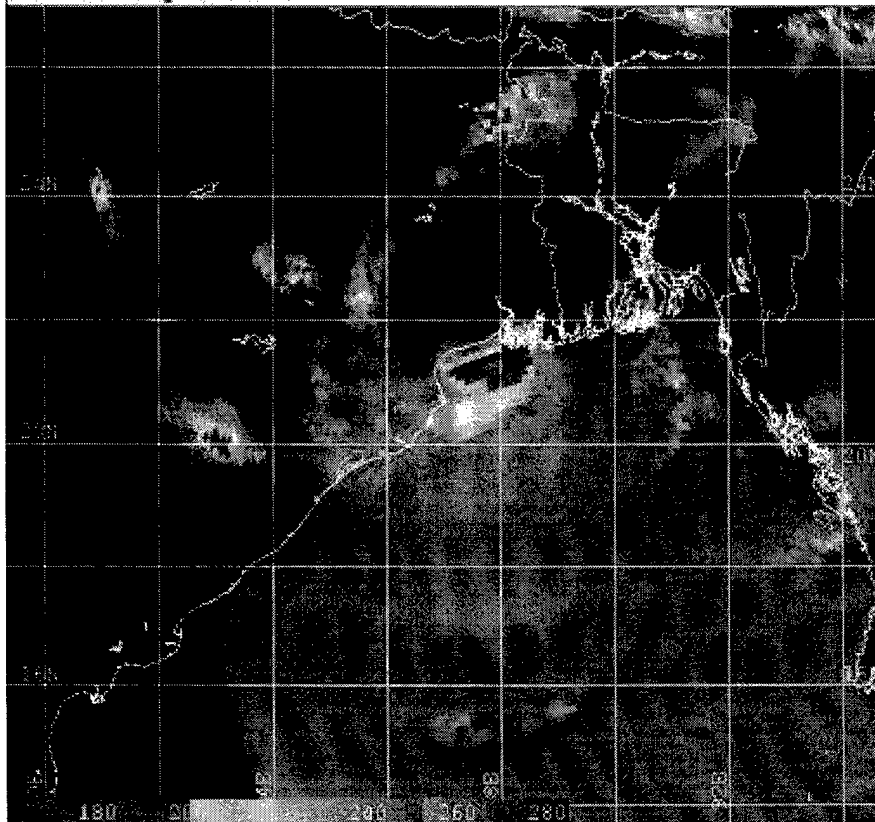
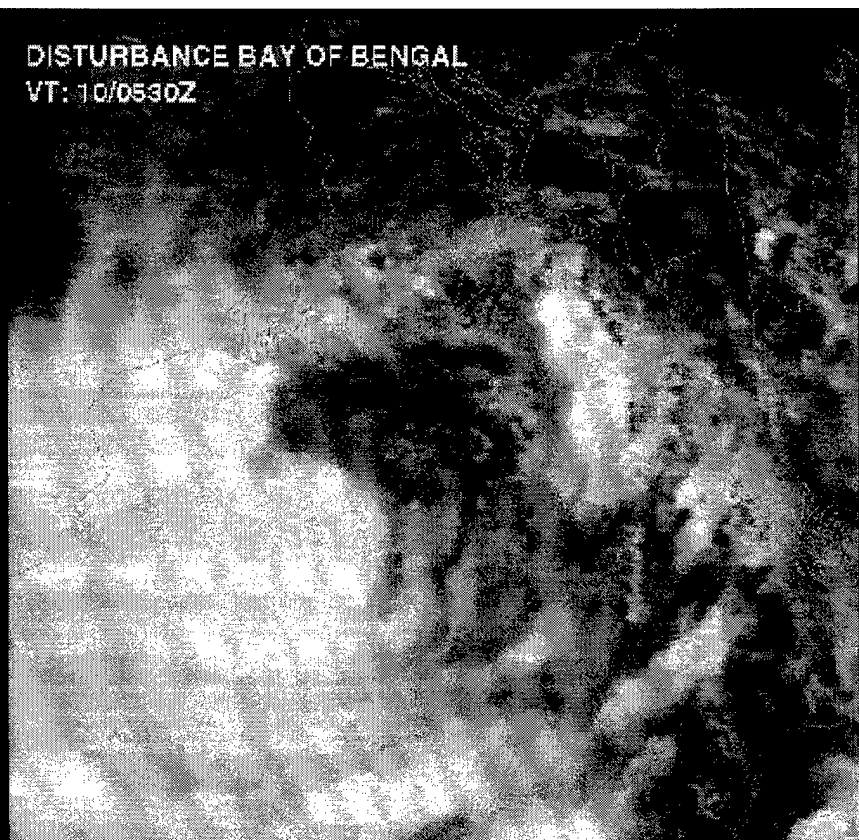


Figure 1-03B-1. 101437Z SSM/I pass over TC 03B as it makes landfall 90 nm southwest of Calcutta. Of note in this image is the strong convection to the south over the water. Interaction with land has served to weaken the system, over land, yet the low-level circulation continues to produce convection over the water.

DISTURBANCE BAY OF BENGAL  
VT: 10/0530Z



BAY OF BENGAL  
VT: 10/1100Z



## Tropical Cyclone 04B

Tropical Cyclone (TC) 04B was the second tropical cyclone that developed over the Bay of Bengal during the 1999 season. This cyclone developed about 220 nm northwest of the Andaman Islands and reached a maximum intensity of 120 kt before making landfall over Gopalpur, India in the Ganjam district at 171730Z October.

JTWC issued a Tropical Cyclone Formation Alert at 151730Z October based on a Special Sensor Microwave/Imager (SSM/I) pass which depicted low level cloud lines over the northwest quadrant moving in toward the system center (Figure 1-04B-1). Subsequently, the first warning was issued at 152100Z October for a 45 kt cyclone.

Tropical Cyclone 04B initially moved west-northwestward at 8 to 12 knots under the influence of the subtropical ridge to the northwest. TC 04B then turned northward around 170600Z October, just before reaching the Orissa coastline. The cyclone slowed on 170000Z October and rapidly intensified to its maximum intensity of 120 kt. TC 04B remained at 120 kt while making landfall over the Orissa coast (Figure 1-04B-2). The cyclone then began to weaken moving northward and dissipating on the 19th of October near Aurangabad. JTWC issued the seventh and final warning at 180900Z October.

CNN and Reuters reported over 80 fatalities, severed communication lines, collapsed buildings and uprooted trees from the eastern Indian state of Orissa. The Ganjam district, specifically the port of Gopalpur, received the brunt of Tropical Cyclone 04B. Hundreds of houses and huts in the low-lying areas of Andhra Pradesh were also reported destroyed by flooding and three fatalities were reported to have occurred in that region.

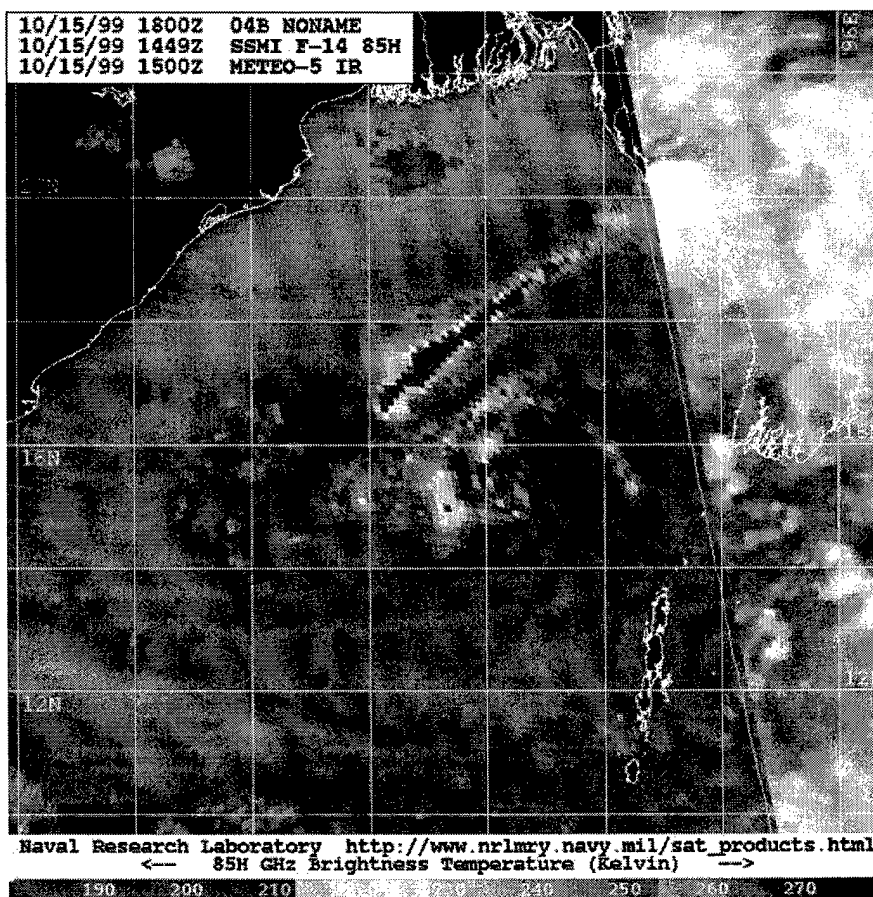


Figure 1-04B-1. 151449Z October combined SSM/I and infrared image from NRL reveals deep convection building in toward the low level circulation center from the northwest. Current intensity was 30 kt, but three hours later it was 45 kt.

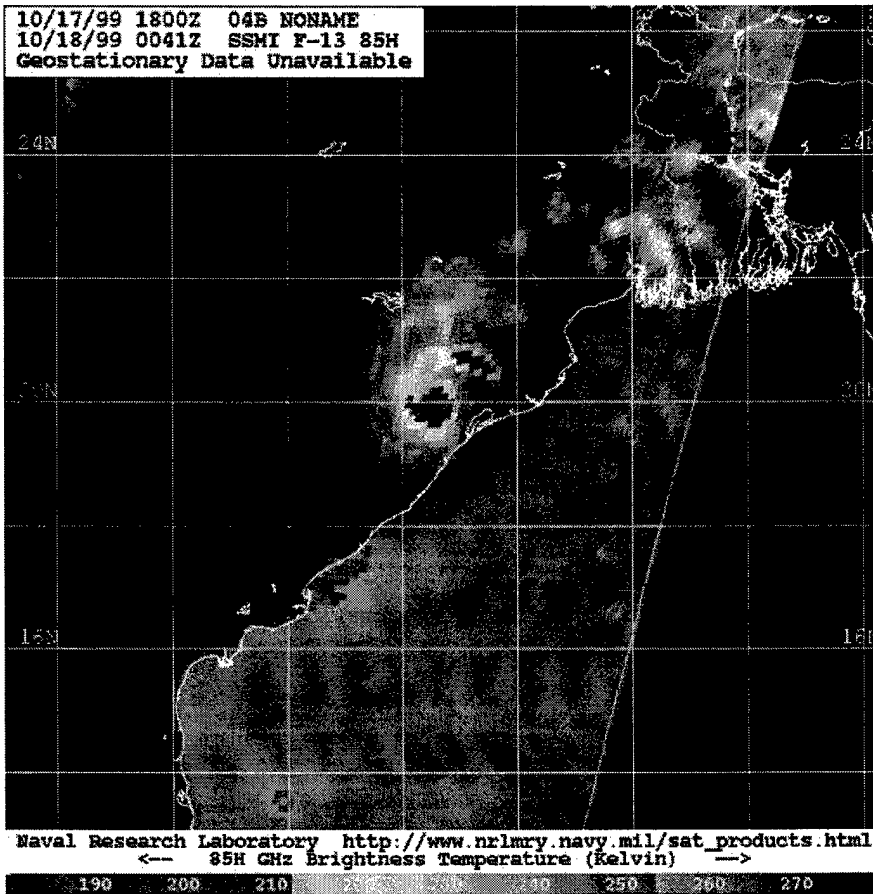
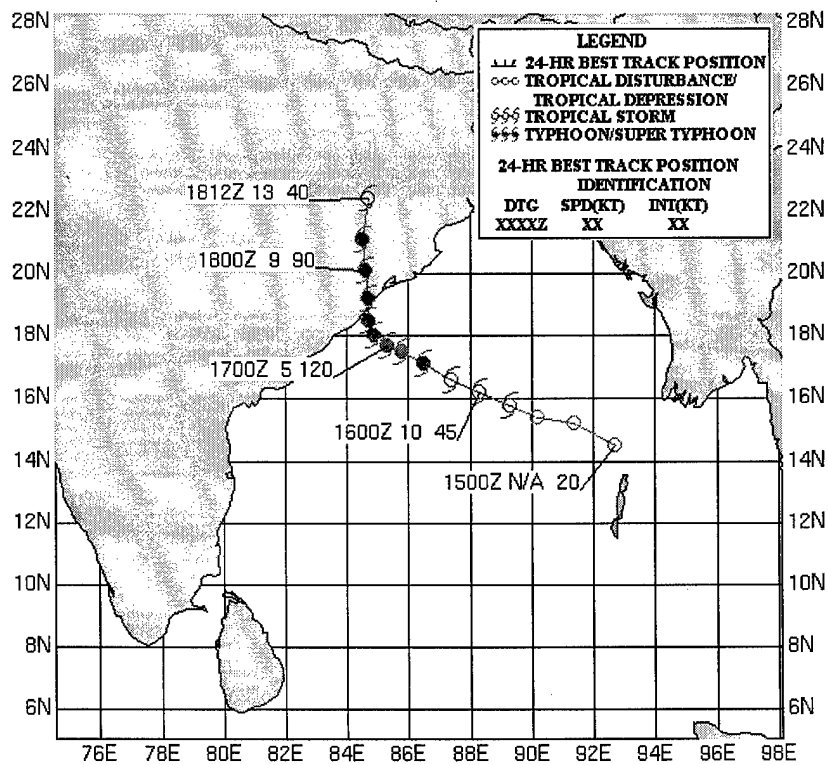


Figure 1-04B-2. 180041Z October SSM/I pass indicates little change in intensity and structure of the system after landfall. Current intensity was 90 kt.



## Tropical Cyclone 05B

Tropical Cyclone (TC) 05B was one of the most significant tropical cyclones on record to affect India, and the worst since 1971. News reports indicate approximately 10,000 fatalities and record flooding as TC 05B made landfall near Bhubaneswar, India around 290500Z October, with maximum winds of 135 kt. Of note, this same region was affected by TC 04B just two weeks earlier as a 120 kt tropical cyclone.

TC 05B developed from a disturbance that originated in the South China Sea and tracked through the Gulf of Thailand and across the Malay peninsula before developing in the Andaman Sea. JTWC issued a TCFA for this South China Sea disturbance on 230200Z October. The disturbance didn't develop and the TCFA was cancelled. Subsequently, JTWC monitored this weak disturbance as it moved into the Andaman Sea, where the convection began to consolidate. A TCFA was issued on 251930Z October and the first warning was issued at 260300Z October as the disturbance developed into a 35 kt cyclone.

TC 05B tracked northwestward and intensified across the Bay of Bengal under the steering influence of the subtropical ridge to the north. The intensification was at a greater than climatological rate, peaking at 281800Z October at 140 kt intensity. TC 05B made landfall 11 hours later as a 135 kt system about 35nm south-southeast of Cuttack and 30 nm southeast of Bhubaneswar, India. Subsequently, TC 05B maintained 100 kt intensity for 12 hours as it dumped torrential rains and battered the coastal areas, then slowly turned southward and moved back over the Bay of Bengal as a 40 kt tropical cyclone. TC 05B continued to drift southward and dissipate over water. JTWC issued the 13th and final warning at 2010300Z November.

News reports indicated this was the worst tropical cyclone to hit India since 1971. MSNBC reported Asim Kumar Vaishan, Chief Administrator of Baleshwar, stated "this is the worst flooding in 100 years. I would say it's the worst in India's history." The UN Office for the Coordination of Humanitarian Affairs (OCHA) Situation Report #11 for 26 November stated "... the death toll now stands at 9,803, with Jagatsinghpur district recording 8,119 victims. Forty persons are still missing and 3,312 have been injured. A total of 1.711 million hectares of crops have been affected. The number of livestock to have perished is 406,000."



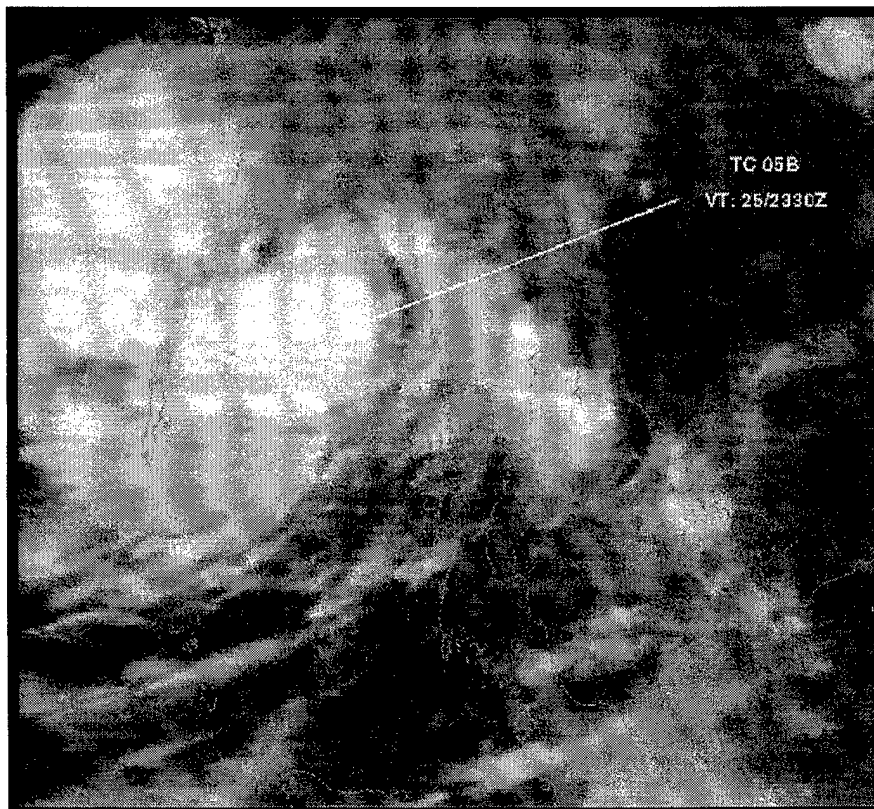


Figure 1-05B-1. 252330Z October GMS-5 infrared image of TC 05B at the initial warning. Intensity was 35 kt.

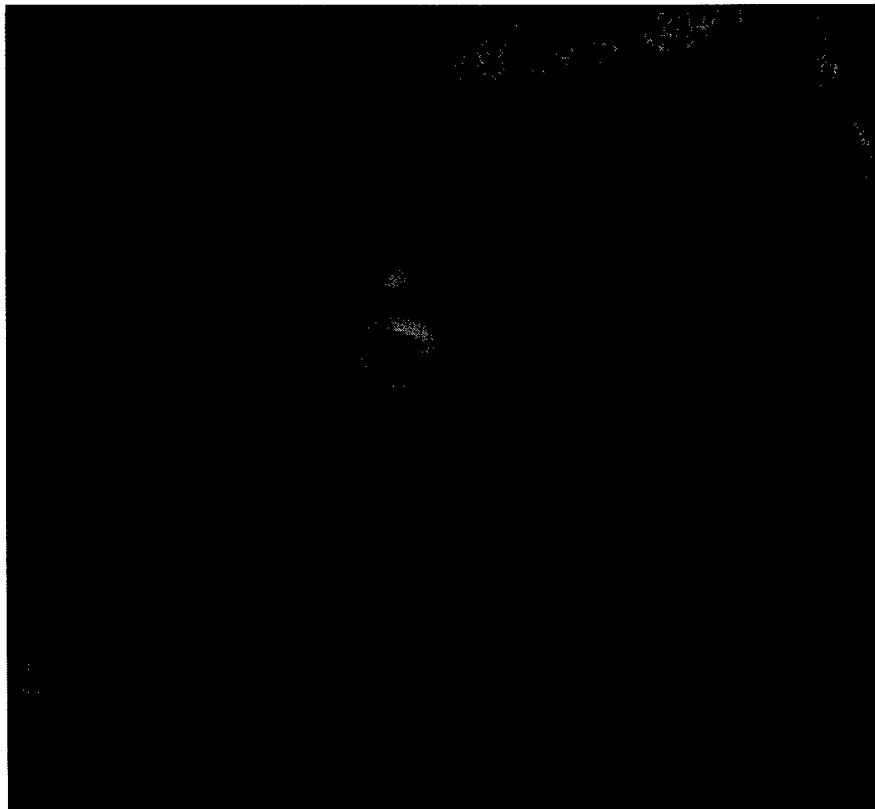


Figure 1-05B-2. 281543Z October Tropical Rainfall Measurement Mission pass of TC 05B. Intensity was 135 kt. TC 05B peaked three hours later at 140 kt.

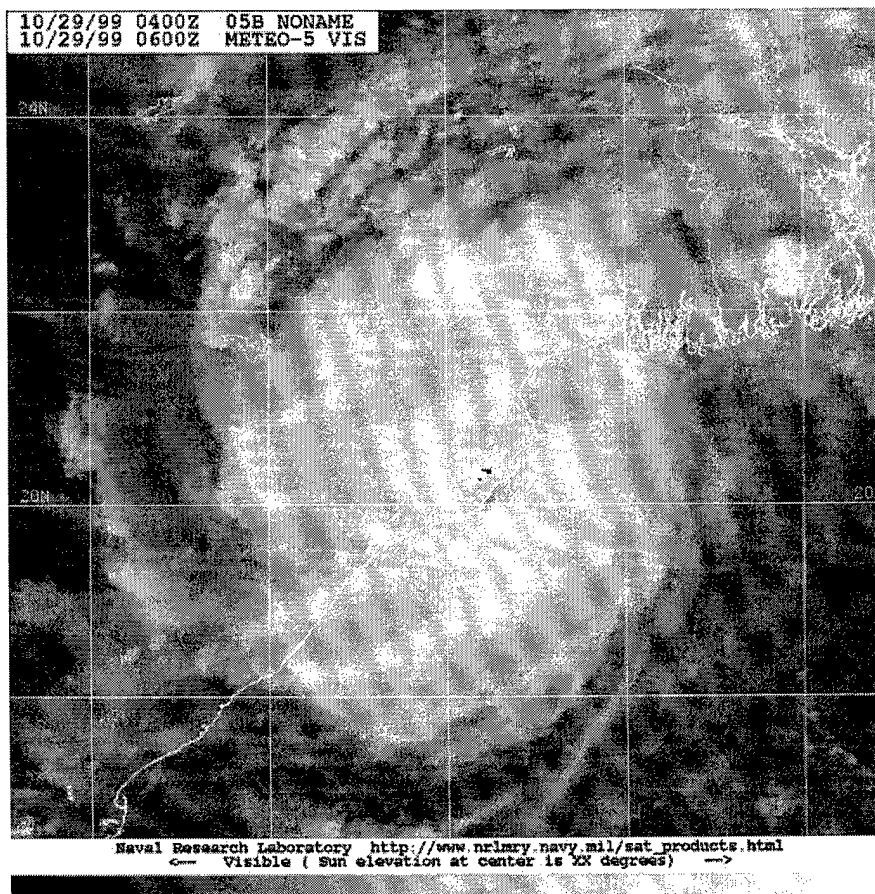
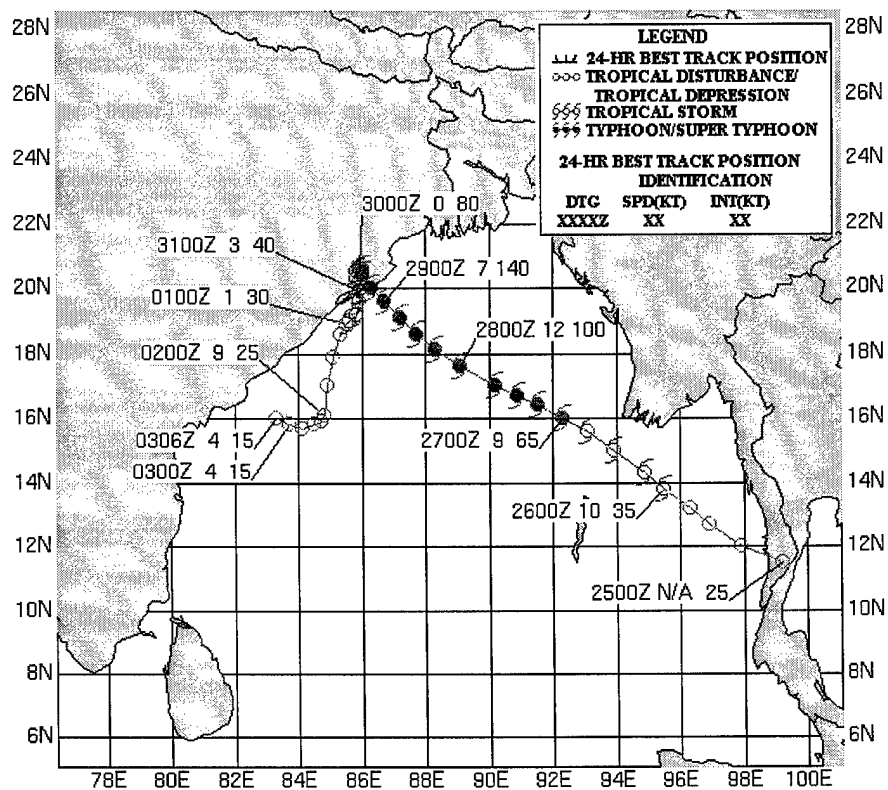
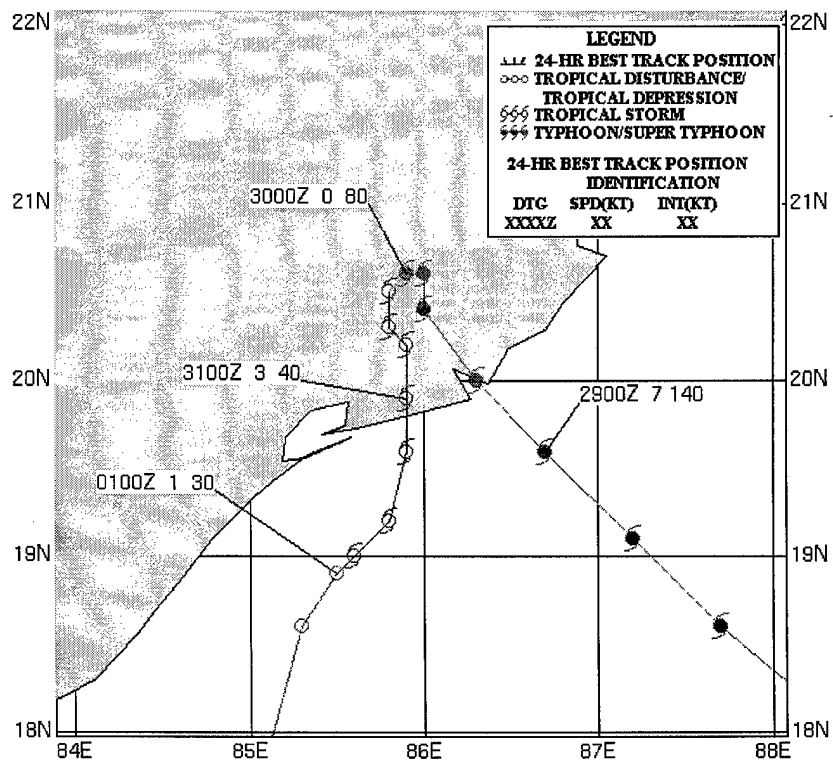


Figure 1-05B-3. 290600Z October METEOSAT-5 visible image of TC 05B. The center of TC 05B made landfall at 0500Z with an intensity of 135 kt.





## 2. SOUTH PACIFIC AND SOUTH INDIAN OCEAN TROPICAL CYCLONES

### 2.1 GENERAL

In accordance with CINCPACINST 3140.1 (series), Southern Hemisphere tropical cyclones are numbered sequentially from 01 July through 30 June to reflect the Southern Hemisphere tropical season.

For warning message delineation, the Southern Hemisphere AOR is divided into two basins; the South Indian (west of 135 East longitude) and the South Pacific Ocean (east of 135 East longitude). The suffixes "S" (South Indian Ocean) and "P" (South Pacific Ocean) are appended to the tropical cyclone number to differentiate warnings for these basins.

### 2.2 SUMMARY

Table 2-1 lists the significant tropical cyclones during this season and can be compared to the climatological mean presented in Table 2-2. Table 2-3 compares this year's tropical cyclone activity in the Southern Hemisphere sub-basins to previous years and climatology. Composites of the tropical cyclone best tracks for the Southern Hemisphere appear in Figures 2-1a, 2-1b, 2-1c, 2-2a, 2-2b, and 2-3.

| TC   | NAME   | PERIOD        | NUMBER<br>ISSUED | EST<br>MAX<br>SFC<br>WINDS<br>KTS<br>(M/SEC) | MSLP<br>(MB) |
|------|--------|---------------|------------------|--|--------------|
| 01S  | -      | 23 JUL 25 JUL | 6                | 40 (21)                                      | 994          |
| 02S  | -      | 29 SEP 02 OCT | 8                | 40 (21)                                      | 994          |
| 03S  | Zelia  | 07 OCT 10 OCT | 8                | 45 (23)                                      | 991          |
| 04S  | Alison | 08 NOV 13 NOV | 11               | 70 (36)                                      | 972          |
| 05S  | Billy  | 02 DEC 06 DEC | 16               | 65 (33)                                      | 976          |
| 06S  | -      | 05 DEC 15 DEC | 21               | 135 (69)                                     | 904          |
| 07P  | -      | 15 DEC 16 DEC | 4                | 35 (18)                                      | 997          |
| *08P | -      | 22 DEC 23 DEC | (3)              | 45 (23)                                      | 991          |
| 09P  | Cora   | 23 DEC 27 DEC | 8                | 90 (46)                                      | 954          |
| 10S  | Cathy  | 25 DEC 28 DEC | 7                | 40 (21)                                      | 994          |
| 11P  | Dani   | 14 JAN 22 JAN | 18               | 115 (59)                                     | 927          |
| 12S  | Alda   | 16 JAN 17 JAN | 5                | 55 (28)                                      | 984          |
| 13P  | Olinda | 20 JAN 25 JAN | 11               | 55 (28)                                      | 984          |
| 14P  | Pete   | 22 JAN 25 JAN | 8                | 50 (26)                                      | 987          |
| 15S  | Damien | 22 JAN 30 JAN | 23               | 80 (41)                                      | 963          |
| 16P  | -      | 25 JAN 26 JAN | 4                | 35 (18)                                      | 997          |

Table 2-1 SOUTHERN HEMISPHERE TROPICAL CYCLONES FOR 1999 (01 JULY 1998 - 30 JUNE 1999)

|      |          |               |      |          |      |
|------|----------|---------------|------|----------|------|
| 17S  | Chikita  | 30 JAN 04 FEB | 11   | 40 (21)  | 994  |
| 18S  | -        | 04 FEB 09 FEB | 18   | 40 (21)  | 994  |
| 19P  | Ella     | 10 FEB 13 FEB | 11   | 45 (23)  | 991  |
| 20P  | Rona     | 10 FEB 12 FEB | 5    | 60 (31)  | 980  |
| 21S  | -        | 13 FEB 15 FEB | 8    | 45 (23)  | 991  |
| 22P  | Frank    | 17 FEB 23 FEB | 18   | 100 (51) | 944  |
| 23S  | -        | 27 FEB 01 MAR | 5    | 30 (15)  | 1000 |
| *24P | -        | 27 FEB 28 FEB | (2)  | 35 (18)  | 997  |
| 25S  | Davina   | 01 FEB 14 MAR | 29   | 105 (54) | 938  |
| 26S  | -        | 07 MAR 09 MAR | 9    | 35 (18)  | 997  |
| *27P | Hali     | 12 MAR 17 MAR | (11) | 50 (26)  | 987  |
| 28S  | Elaine   | 16 MAR 19 MAR | 9    | 100 (51) | 944  |
| 29S  | -        | 17 MAR 19 MAR | 8    | 35 (18)  | 997  |
| 30S  | Vance    | 18 MAR 23 MAR | 17   | 125 (64) | 916  |
| 31S  | Frederic | 26 MAR 07 APR | 28   | 140 (72) | 898  |
| 32S  | Gwenda   | 05 APR 07 APR | 10   | 130 (67) | 910  |
| 33S  | Hamish   | 19 APR 24 APR | 10   | 45 (23)  | 991  |

JTWC TOTAL 354

( )NPMOC TOTAL (16)

GRAND TOTAL 370

\*WARNINGS ISSUED BY NPMOC

Table 2-2 MONTHLY DISTRIBUTION OF SOUTH PACIFIC AND SOUTH INDIAN OCEAN TROPICAL CYCLONES

| YEAR           | JUL | AUG | SEP | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | TOTAL |
|----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|
| 1958-1977 AVE* | -   | -   | -   | 0.4 | 1.5 | 3.6 | 6.1 | 5.8 | 4.7 | 2.1 | 0.5 | -   | 24.7  |
| 1981           | 0   | 0   | 0   | 1   | 3   | 2   | 6   | 5   | 3   | 3   | 1   | 0   | 24    |
| 1982           | 1   | 0   | 0   | 1   | 1   | 3   | 9   | 4   | 2   | 3   | 1   | 0   | 25    |
| 1983           | 1   | 0   | 0   | 1   | 1   | 3   | 5   | 6   | 3   | 5   | 0   | 0   | 25    |
| 1984           | 1   | 0   | 0   | 1   | 2   | 5   | 5   | 10  | 4   | 2   | 0   | 0   | 30    |
| 1985           | 0   | 0   | 0   | 0   | 1   | 7   | 9   | 9   | 6   | 3   | 0   | 0   | 35    |
| 1986           | 0   | 0   | 1   | 0   | 1   | 1   | 9   | 9   | 6   | 4   | 2   | 0   | 33    |
| 1987           | 0   | 1   | 0   | 0   | 1   | 3   | 6   | 8   | 3   | 4   | 1   | 1   | 28    |
| 1988           | 0   | 0   | 0   | 0   | 2   | 3   | 5   | 5   | 3   | 1   | 2   | 0   | 21    |
| 1989           | 0   | 0   | 0   | 0   | 2   | 1   | 5   | 8   | 6   | 4   | 2   | 0   | 28    |
| 1990           | 2   | 0   | 1   | 1   | 2   | 2   | 4   | 4   | 10  | 2   | 1   | 0   | 29    |
| 1991           | 0   | 0   | 1   | 1   | 1   | 3   | 2   | 5   | 5   | 2   | 1   | 1   | 22    |
| 1992           | 0   | 0   | 1   | 1   | 2   | 5   | 4   | 11  | 3   | 2   | 1   | 0   | 30    |
| 1993           | 0   | 0   | 1   | 1   | 0   | 5   | 7   | 7   | 2   | 2   | 2   | 0   | 27    |
| 1994           | 0   | 0   | 0   | 0   | 2   | 4   | 8   | 4   | 9   | 3   | 0   | 0   | 30    |
| 1995           | 0   | 0   | 0   | 0   | 2   | 2   | 5   | 4   | 5   | 4   | 0   | 0   | 22    |
| 1996           | 0   | 0   | 0   | 0   | 1   | 3   | 7   | 6   | 6   | 4   | 1   | 0   | 28    |
| 1997           | 1   | 1   | 1   | 2   | 2   | 6   | 9   | 8   | 3   | 1   | 3   | 1   | 38    |
| 1998           | 1   | 0   | 0   | 3   | 2   | 3   | 7   | 9   | 6   | 6   | 0   | 0   | 37    |

Table 2-2 MONTHLY DISTRIBUTION OF SOUTH PACIFIC AND SOUTH INDIAN OCEAN TROPICAL CYCLONES

|                        |     |     |     |     |     |     |     |     |     |     |     |     |      |
|------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| 1999                   | 1   | 0   | 1   | 1   | 1   | 5   | 7   | 6   | 6   | 2   | 0   | 0   | 30   |
| TOTAL                  | 8   | 2   | 7   | 14  | 29  | 66  | 119 | 128 | 91  | 57  | 18  | 3   | 542  |
| AVERAGE<br>(1981-1999) | 0.4 | 0.1 | 0.4 | 0.7 | 1.5 | 3.5 | 6.2 | 6.7 | 4.8 | 3.0 | 0.9 | 0.2 | 28.5 |

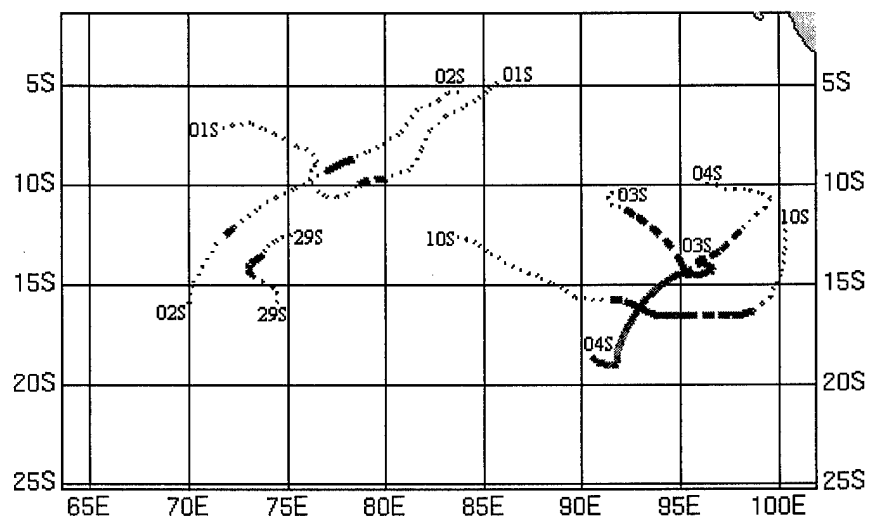
\*  
(Gray,  
1978)

Table 2-3 ANNUAL VARIATION OF SOUTHERN HEMISPHERE TROPICAL CYCLONE BY OCEAN BASIN

| YEAR                       | SOUTH IN-<br>DIAN<br>(WEST OF<br>105E) | AUSTRALIAN<br>(105E<br>165E) | SOUTH<br>PACIFIC<br>(EAST OF<br>165E) | TOTAL |
|----------------------------|--|------------------------------|---------------------------------------|-------|
| 1958-1977<br>AVER-<br>AGE* | 8.4                                    | 10.3                         | 5.9                                   | 24.6  |
| 1981                       | 13                                     | 8                            | 3                                     | 24    |
| 1982                       | 12                                     | 11                           | 2                                     | 25    |
| 1983                       | 7                                      | 6                            | 12                                    | 25    |
| 1984                       | 14                                     | 14                           | 2                                     | 30    |
| 1985                       | 14                                     | 15                           | 6                                     | 35    |
| 1986                       | 14                                     | 16                           | 3                                     | 33    |
| 1987                       | 9                                      | 8                            | 11                                    | 28    |
| 1988                       | 14                                     | 2                            | 5                                     | 21    |
| 1989                       | 12                                     | 9                            | 7                                     | 28    |
| 1990                       | 18                                     | 8                            | 3                                     | 29    |
| 1991                       | 11                                     | 10                           | 1                                     | 22    |
| 1992                       | 11                                     | 6                            | 13                                    | 30    |
| 1993                       | 10                                     | 16                           | 1                                     | 27    |
| 1994                       | 16                                     | 10                           | 4                                     | 30    |
| 1995                       | 11                                     | 7                            | 4                                     | 22    |
| 1996                       | 13                                     | 11                           | 4                                     | 28    |
| 1997                       | 17                                     | 5                            | 16                                    | 38    |
| 1998                       | 12                                     | 10                           | 15                                    | 37    |
| 1999                       | 14                                     | 11                           | 5                                     | 30    |
| (1981-1999)                |  |                              |                                       |       |
| TOTAL                      | 242                                    | 183                          | 107                                   | 542   |
| AVERAGE                    | 12.7                                   | 9.6                          | 5.6                                   | 28.5  |

\* (Gray,1978)

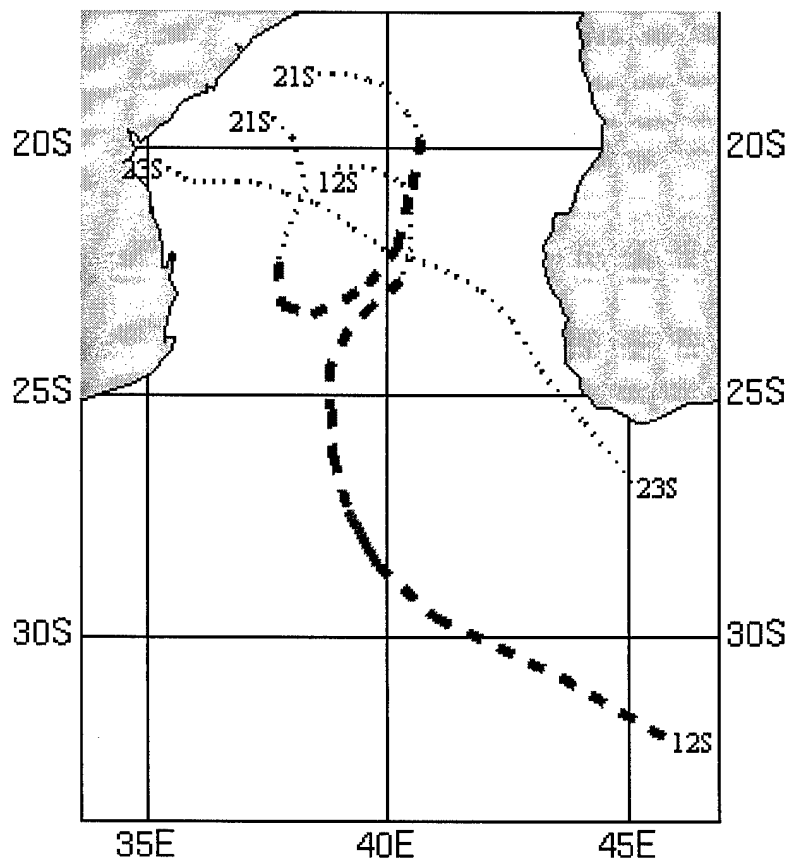




SOUTH INDIAN OCEAN  
TROPICAL CYCLONES  
23 JUL 98 - 19 MAR 99

**MAXIMUM SUSTAINED SURFACE WIND**  
 ————— 64KT (33M/SEC) OR GREATER  
 - - - - - 34 TO 63KT (18 TO 32M/SEC)  
 ..... 33KT (17M/SEC) OR LESS

TC 01 23 JUL - 25 JUL  
 TC 02 29 SEP - 02 OCT  
 TC 03 07 OCT - 10 OCT  
 TC 04 08 NOV - 13 NOV  
 TC 10 25 DEC - 28 DEC  
 TC 29 17 MAR - 19 MAR

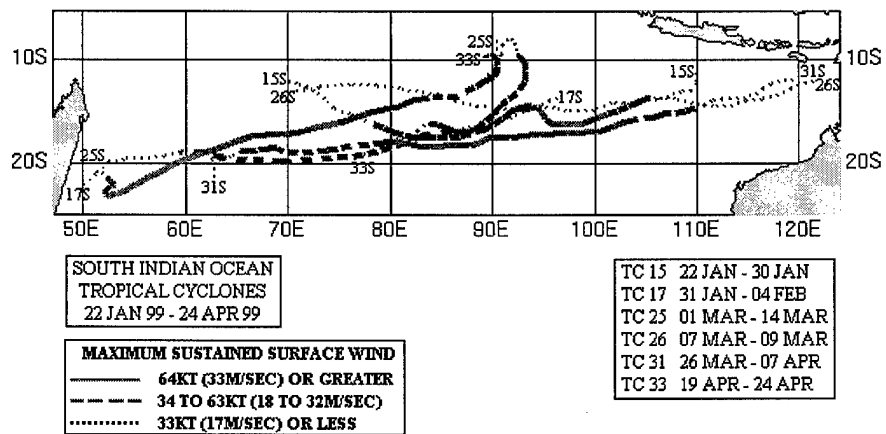


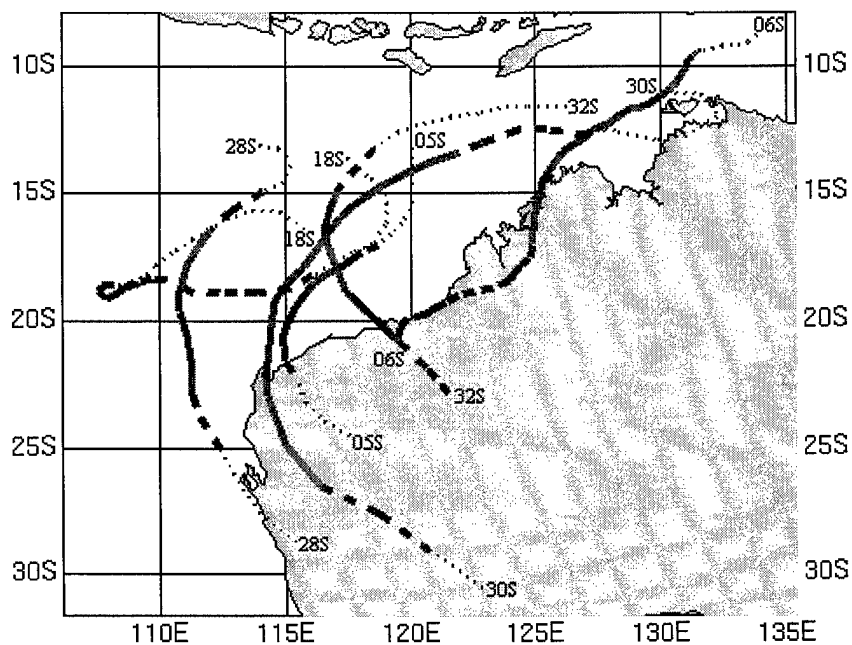
SOUTH INDIAN OCEAN  
TROPICAL CYCLONES  
16 JAN 99 - 01 MAR 99

TC 12 16 JAN - 17 JAN  
TC 21 13 FEB - 15 FEB  
TC 23 27 FEB - 01 MAR

**MAXIMUM SUSTAINED SURFACE WIND**

———— 64KT (33M/SEC) OR GREATER  
----- 34 TO 63KT (18 TO 32M/SEC)  
..... 33KT (17M/SEC) OR LESS

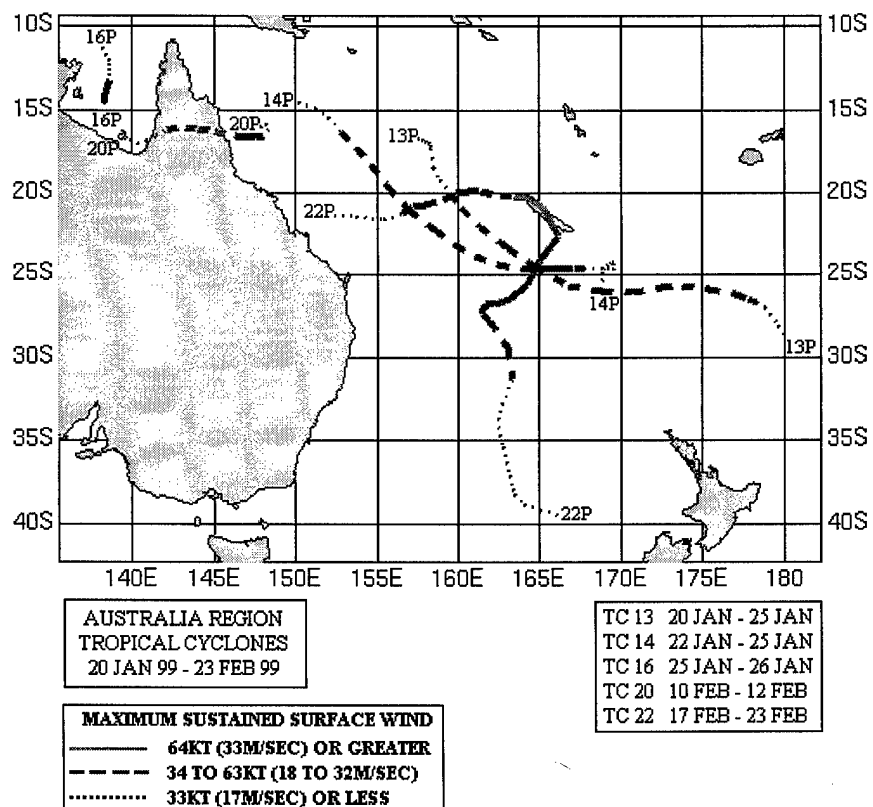


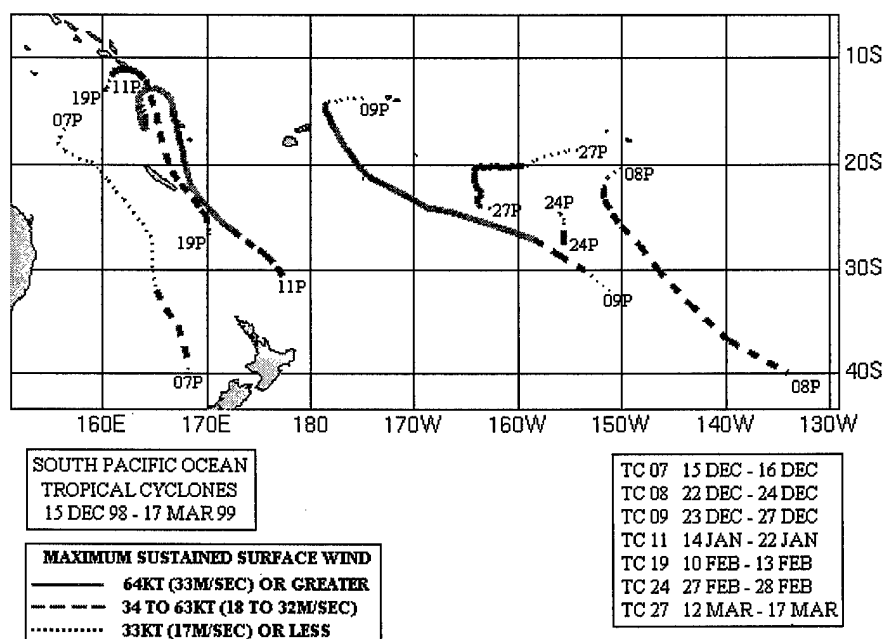


AUSTRALIA REGION  
TROPICAL CYCLONES  
02 DEC 98 - 07 APR 99

**MAXIMUM SUSTAINED SURFACE WIND**  
 ————— 64KT (33M/SEC) OR GREATER  
 - - - - - 34 TO 63KT (18 TO 32M/SEC)  
 ..... 33KT (17M/SEC) OR LESS

TC 05 02 DEC - 06 DEC  
 TC 06 05 DEC - 15 DEC  
 TC 18 04 FEB - 09 FEB  
 TC 28 16 MAR - 19 MAR  
 TC 30 18 MAR - 23 MAR  
 TC 32 05 APR - 07 APR





### 3. SUMMARY OF FORECAST VERIFICATION

#### 3.1 ANNUAL FORECAST VERIFICATION

Verification of warning positions and intensities at initial, 12-, 24-, 48-, and 72-hour forecast periods are made against the final best track. The (scalar) track forecast, along-track and cross-track errors (illustrated in Figure 3-1) were calculated for each verifying JTWC forecast. These data, in addition to a detailed summary for each tropical cyclone, are included as Chapter 4. This section summarizes verification data this year and contrasts it with annual verification statistics from previous years.

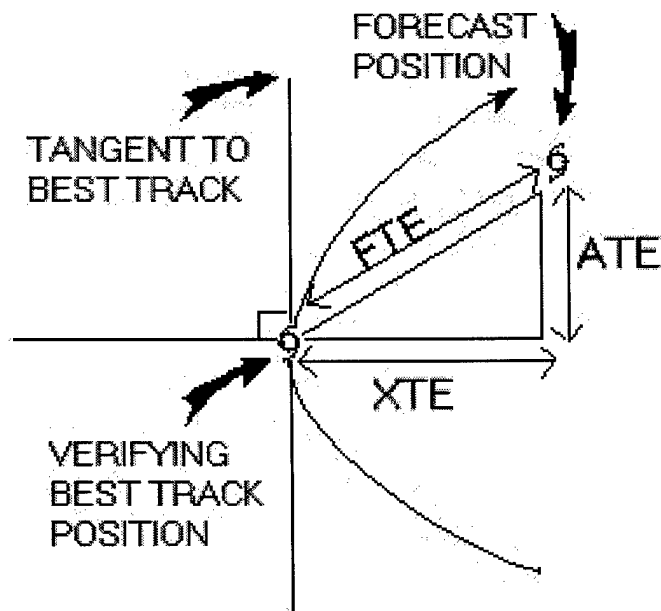


Figure 3-1. Definition of cross-track error (XTE), along-track error (ATE) and forecast track error (FTE). In this example, the forecast position is ahead of and to the right of the verifying best track position. Therefore, the XTE is positive (to the right of the best track) and the ATE is positive (ahead or faster than the best track). Adapted from Tsui and Miller, 1988.

### 3.1.1 NORTHWEST PACIFIC OCEAN

Table 3-1 includes mean track, along-track and cross-track errors for a 15-year period. Figure 3-2 shows mean track errors and a 5-year running mean of track errors at 24-, 48- and 72-hours since 1974. Table 3-2 lists annual mean track errors from 1959, when JTWC was founded, until the present.

Table 3-1 INITIAL POSITION AND FORECAST ERRORS (NM) FOR THE NORTH WEST PACIFIC 1985-1999

|             | Initial Position |       | 24-Hour |       |       |       | 48-Hour |       |       |       | 72-Hour |       |       |       |
|-------------|------------------|-------|---------|-------|-------|-------|---------|-------|-------|-------|---------|-------|-------|-------|
|             | Number           | Error | Number  | Track | Along | Cross | Number  | Track | Along | Cross | Number  | Track | Along | Cross |
| 1985        | 592              | 18    | 477     | 117   | 80    | 68    | 336     | 231   | 153   | 138   | 241     | 367   | 230   | 227   |
| 1986        | 743              | 21    | 645     | 126   | 85    | 70    | 535     | 261   | 183   | 151   | 412     | 394   | 276   | 227   |
| 1987        | 657              | 18    | 563     | 107   | 71    | 64    | 465     | 204   | 134   | 127   | 389     | 303   | 198   | 186   |
| 1988        | 465              | 23    | 373     | 114   | 85    | 58    | 262     | 216   | 170   | 103   | 183     | 315   | 244   | 159   |
| 1989        | 710              | 20    | 625     | 120   | 83    | 69    | 481     | 231   | 162   | 127   | 363     | 350   | 265   | 177   |
| 1990        | 794              | 21    | 658     | 103   | 72    | 60    | 525     | 203   | 148   | 110   | 432     | 310   | 225   | 168   |
| 1991        | 835              | 22    | 733     | 96    | 69    | 53    | 599     | 185   | 137   | 97    | 484     | 287   | 229   | 146   |
| 1992        | 941              | 25    | 841     | 107   | 77    | 59    | 687     | 205   | 143   | 116   | 568     | 305   | 210   | 172   |
| 1993        | 853              | 26    | 725     | 112   | 79    | 63    | 570     | 212   | 151   | 117   | 437     | 321   | 226   | 173   |
| 1994        | 1058             | 24    | 932     | 98    | 85    | 62    | 753     | 176   | 158   | 105   | 608     | 242   | 218   | 144   |
| 1995        | 559              | 29    | 539     | 123   | 89    | 67    | 421     | 215   | 159   | 117   | 319     | 325   | 240   | 167   |
| 1996        | 922              | 25    | 880     | 105   | 76    | 56    | 711     | 178   | 134   | 89    | 607     | 272   | 203   | 137   |
| 1997        | 910              | 20    | 865     | 93    | 76    | 55    | 752     | 164   | 134   | 87    | 642     | 245   | 202   | 120   |
| 1998        | 450              | 22    | 375     | 124   | 98    | 58    | 273     | 239   | 178   | 127   | 202     | 370   | 274   | 201   |
| 1999        | 583              | 15    | 445     | 106   | 74    | 59    | 307     | 176   | 119   | 102   | 197     | 234   | 155   | 139   |
| (1985-1999) |                  |       |         |       |       |       |         |       |       |       |         |       |       |       |
| Avg         | 738              | 22    | 645     | 110   | 80    | 62    | 512     | 206   | 151   | 114   | 406     | 309   | 227   | 170   |

Table 3-2 MEAN FORECAST TRACK ERRORS (NM) FOR WESTERN NORTH PACIFIC TROPICAL CYCLONES FOR 1959-1999

| YEAR<br>(Notes) | 24-HOUR |        |                       |                       | 48-HOUR |        |                       |                       | 72-HOUR |        |                       |                       |
|-----------------|---------|--------|-----------------------|-----------------------|---------|--------|-----------------------|-----------------------|---------|--------|-----------------------|-----------------------|
|                 | TY (1)  | TC (3) | CROSS<br>TRACK<br>(2) | ALONG<br>TRACK<br>(2) | TY (1)  | TC (3) | CROSS<br>TRACK<br>(2) | ALONG<br>TRACK<br>(2) | TY (1)  | TC (3) | CROSS<br>TRACK<br>(2) | ALONG<br>TRACK<br>(2) |
| 1959            | 117*    |        |                       |                       | 267*    |        |                       |                       |         |        |                       |                       |
| 1960            | 177*    |        |                       |                       | 354*    |        |                       |                       |         |        |                       |                       |
| 1961            | 136     |        |                       |                       | 274     |        |                       |                       |         |        |                       |                       |
| 1962            | 144     |        |                       |                       | 287     |        |                       |                       | 476     |        |                       |                       |
| 1963            | 127     |        |                       |                       | 246     |        |                       |                       | 374     |        |                       |                       |
| 1964            | 133     |        |                       |                       | 284     |        |                       |                       | 429     |        |                       |                       |
| 1965            | 151     |        |                       |                       | 303     |        |                       |                       | 418     |        |                       |                       |
| 1966            | 136     |        |                       |                       | 280     |        |                       |                       | 432     |        |                       |                       |
| 1967            | 125     |        |                       |                       | 276     |        |                       |                       | 414     |        |                       |                       |
| 1968            | 105     |        |                       |                       | 229     |        |                       |                       | 337     |        |                       |                       |
| 1969            | 111     |        |                       |                       | 237     |        |                       |                       | 349     |        |                       |                       |
| 1970            | 98      | 104    |                       |                       | 181     | 190    |                       |                       | 272     | 279    |                       |                       |
| 1971            | 99      | 111    | 64                    |                       | 203     | 212    | 118                   |                       | 308     | 317    | 177                   |                       |



Table 3-2 MEAN FORECAST TRACK ERRORS (NM) FOR WESTERN NORTH PACIFIC TROPICAL CYCLONES FOR 1959-1999

|          |     |     |    |    |     |     |     |     |     |     |     |
|----------|-----|-----|----|----|-----|-----|-----|-----|-----|-----|-----|
| 1972     | 116 | 117 | 72 |    | 245 | 245 | 146 |     | 382 | 381 | 210 |
| 1973     | 102 | 108 | 74 |    | 193 | 197 | 134 |     | 245 | 253 | 162 |
| 1974     | 114 | 120 | 78 |    | 218 | 226 | 157 |     | 357 | 348 | 245 |
| 1975     | 129 | 138 | 84 |    | 279 | 288 | 181 |     | 442 | 450 | 290 |
| 1976     | 117 | 117 | 71 |    | 232 | 230 | 132 |     | 336 | 338 | 202 |
| 1977     | 140 | 148 | 83 |    | 266 | 283 | 157 |     | 390 | 407 | 228 |
| 1978     | 120 | 127 | 71 | 87 | 241 | 271 | 151 | 194 | 459 | 410 | 218 |
| 1979     | 113 | 124 | 76 | 81 | 219 | 226 | 138 | 146 | 319 | 316 | 182 |
| 1980     | 116 | 126 | 76 | 86 | 221 | 243 | 147 | 165 | 362 | 389 | 230 |
| 1981     | 117 | 124 | 77 | 80 | 215 | 221 | 131 | 146 | 342 | 334 | 219 |
| 1982     | 114 | 113 | 70 | 74 | 229 | 238 | 142 | 162 | 337 | 342 | 211 |
| 1983     | 110 | 117 | 73 | 76 | 247 | 260 | 164 | 169 | 384 | 407 | 263 |
| 1984     | 110 | 117 | 64 | 84 | 228 | 232 | 131 | 163 | 361 | 363 | 216 |
| 1985     | 112 | 117 | 68 | 80 | 228 | 231 | 138 | 153 | 355 | 367 | 227 |
| 1986     | 117 | 126 | 70 | 85 | 261 | 261 | 151 | 183 | 403 | 394 | 227 |
| 1987     | 101 | 107 | 64 | 71 | 211 | 204 | 127 | 134 | 318 | 303 | 186 |
| 1988     | 107 | 114 | 58 | 85 | 222 | 216 | 103 | 170 | 327 | 315 | 159 |
| 1989     | 107 | 120 | 69 | 83 | 214 | 231 | 127 | 162 | 325 | 350 | 177 |
| 1990     | 98  | 103 | 60 | 72 | 191 | 203 | 110 | 148 | 299 | 310 | 168 |
| 1991     | 93  | 96  | 53 | 69 | 187 | 185 | 97  | 137 | 298 | 287 | 146 |
| 1992     | 97  | 107 | 59 | 77 | 194 | 205 | 116 | 143 | 295 | 305 | 172 |
| 1993     | 102 | 112 | 63 | 79 | 205 | 212 | 117 | 151 | 320 | 321 | 173 |
| 1994**   | 96  | 105 | 56 | 76 | 172 | 186 | 105 | 131 | 244 | 258 | 152 |
| 1995     | 105 | 123 | 67 | 89 | 200 | 215 | 117 | 159 | 311 | 325 | 167 |
| 1996     | 85  | 105 | 56 | 76 | 157 | 178 | 89  | 134 | 252 | 272 | 137 |
| 1997     | 86  | 93  | 55 | 76 | 159 | 164 | 87  | 134 | 251 | 245 | 120 |
| 1998     | 127 | 124 | 58 | 98 | 263 | 239 | 127 | 178 | 392 | 370 | 201 |
| 1999     | 88  | 106 | 59 | 74 | 150 | 176 | 102 | 119 | 225 | 234 | 139 |
| Averages | 108 | 108 | 63 | 73 | 215 | 208 | 121 | 140 | 328 | 312 | 181 |

1. Forecasts were verified for typhoons when intensities were at least 35kt at warning times

2. Cross-track and along-track errors were adopted by the JTWC in 1986. Right angle errors (used prior to 1986) were recomputed as cross-track errors after-the fact to extend the data base. See Figure 3-1 for the definitions of cross-track and along-track.

3. Mean forecast errors for all warned systems in Northwest Pacific.

\*Forecast positions north of 35 degrees North latitude were not verified.

\*\*1994 statistics were recalculated to resolve earlier Along and Cross-Track discrepancies.

### 3.1.2 NORTH INDIAN OCEAN

Table 3-3 includes mean track, along-track and cross-track errors for a 15-year period. Figure 3-3 shows mean track errors and a 5-year running mean of track errors at 24-, 48- and 72-hours since 1981.

Table 3-3 JTWC INITIAL POSITION AND FORECAST ERRORS (NM) FOR THE NORTHERN INDIAN OCEAN 1985-1999

|      | Initial Position |       | 24-Hour |       |       |       | 48-Hour |       |       |       | 72-Hour |       |       |       |
|------|------------------|-------|---------|-------|-------|-------|---------|-------|-------|-------|---------|-------|-------|-------|
|      | Number           | Error | Number  | Track | Along | Cross | Number  | Track | Along | Cross | Number  | Track | Along | Cross |
| 1985 | 53               | 31    | 30      | 122   | 102   | 53    | 8       | 242   | 119   | 194   | 0       |       |       |       |

Table 3-3 JTWC INITIAL POSITION AND FORECAST ERRORS (NM) FOR THE NORTHERN INDIAN OCEAN 1985-1999

|                                       |     |    |     |     |     |     |     |     |     |     |    |      |      |      |
|---------------------------------------|-----|----|-----|-----|-----|-----|-----|-----|-----|-----|----|------|------|------|
| 1986                                  | 28  | 52 | 16  | 134 | 118 | 53  | 7   | 168 | 131 | 80  | 5  | 269  | 189  | 180  |
| 1987                                  | 83  | 42 | 54  | 144 | 97  | 100 | 25  | 205 | 125 | 140 | 21 | 305  | 219  | 188  |
| 1988                                  | 44  | 34 | 30  | 120 | 89  | 63  | 18  | 219 | 112 | 176 | 12 | 409  | 227  | 303  |
| 1989                                  | 44  | 19 | 33  | 88  | 62  | 50  | 17  | 146 | 94  | 86  | 12 | 216  | 164  | 11   |
| 1990                                  | 46  | 31 | 36  | 101 | 85  | 43  | 24  | 146 | 117 | 67  | 17 | 185  | 130  | 104  |
| 1991                                  | 56  | 38 | 43  | 129 | 107 | 54  | 27  | 235 | 200 | 89  | 14 | 450  | 356  | 178  |
| 1992                                  | 191 | 35 | 149 | 128 | 73  | 86  | 100 | 244 | 141 | 166 | 62 | 398  | 276  | 218  |
| 1993                                  | 36  | 27 | 28  | 125 | 87  | 79  | 20  | 198 | 171 | 74  | 12 | 231  | 176  | 116  |
| 1994                                  | 60  | 25 | 44  | 97  | 80  | 44  | 28  | 153 | 124 | 63  | 13 | 213  | 177  | 92   |
| 1995                                  | 54  | 30 | 47  | 138 | 119 | 58  | 32  | 262 | 247 | 77  | 20 | 342  | 304  | 109  |
| 1996                                  | 135 | 33 | 123 | 134 | 94  | 80  | 85  | 238 | 181 | 127 | 58 | 311  | 172  | 237  |
| 1997                                  | 56  | 29 | 42  | 119 | 87  | 49  | 29  | 201 | 168 | 92  | 17 | 228  | 195  | 110  |
| 1998                                  | 80  | 20 | 55  | 106 | 84  | 51  | 34  | 198 | 135 | 106 | 17 | 262  | 188  | 144  |
| 1999                                  | 49  | 8  | 41  | 79  | 59  | 38  | 22  | 184 | 130 | 116 | 10 | 374  | 309  | 177  |
| (1985-1999)                           |     |    |     |     |     |     |     |     |     |     |    |      |      |      |
| Avg                                   | 68  | 30 | 50  | 120 | 92  | 60  | 31  | 207 | 151 | 112 | 20 | 280* | 206* | 145* |
| *14 year average (1985 not available) |     |    |     |     |     |     |     |     |     |     |    |      |      |      |

### 3.1.3 SOUTH PACIFIC AND SOUTH INDIAN OCEANS

Table 3-4 includes mean track, along-track and cross-track errors for a 15-year period. Figure 3-4 shows mean track errors and a 5-year running mean of track errors at 24-, 48- and 72-hours since 1981.

Table 3-4 JTWC INITIAL POSITION AND FORECAST ERRORS (NM) FOR THE SOUTHERN HEMISPHERE 1985-1999

|                 | Initial Position |       | 24-Hour |       |       |       | 48-Hour |       |       |       | 72-Hour |       |       |       |
|-----------------|------------------|-------|---------|-------|-------|-------|---------|-------|-------|-------|---------|-------|-------|-------|
|                 | Number           | Error | Number  | Track | Along | Cross | Number  | Track | Along | Cross | Number  | Track | Along | Cross |
| 1985            | 306              | 36    | 257     | 134   | 92    | 79    | 193     | 236   | 169   | 132   |         |       |       |       |
| 1986            | 279              | 40    | 227     | 129   | 86    | 77    | 171     | 262   | 169   | 164   |         |       |       |       |
| 1987            | 189              | 46    | 138     | 145   | 94    | 90    | 101     | 280   | 153   | 138   |         |       |       |       |
| 1988            | 204              | 34    | 99      | 146   | 98    | 83    | 48      | 290   | 246   | 144   |         |       |       |       |
| 1989            | 287              | 31    | 242     | 124   | 84    | 73    | 186     | 240   | 166   | 136   |         |       |       |       |
| 1990            | 272              | 27    | 228     | 143   | 105   | 74    | 177     | 263   | 178   | 152   |         |       |       |       |
| 1991            | 264              | 24    | 231     | 115   | 75    | 69    | 185     | 220   | 152   | 129   |         |       |       |       |
| 1992            | 267              | 28    | 230     | 124   | 91    | 64    | 208     | 240   | 177   | 129   |         |       |       |       |
| 1993            | 257              | 21    | 225     | 102   | 74    | 57    | 176     | 199   | 142   | 114   |         |       |       |       |
| 1994            | 386              | 28    | 345     | 115   | 77    | 68    | 282     | 224   | 147   | 134   |         |       |       |       |
| 1995            | 245              | 24    | 222     | 108   | 82    | 55    | 175     | 198   | 144   | 108   | 53      | 291   | 169   | 190   |
| 1996            | 343              | 24    | 298     | 125   | 90    | 67    | 237     | 240   | 174   | 129   | 46      | 277   | 221   | 133   |
| 1997            | 561              | 24    | 499     | 109   | 82    | 72    | 442     | 210   | 163   | 135   | 150     | 288   | 248   | 175   |
| 1998            | 329              | 26    | 305     | 111   | 85    | 52    | 245     | 219   | 169   | 108   | 81      | 349   | 261   | 171   |
| 1999            | 348              | 17    | 322     | 113   | 80    | 64    | 245     | 226   | 159   | 132   | 59      | 286   | 198   | 164   |
| (1985-1999)     |                  |       |         |       |       |       |         |       |       |       |         |       |       |       |
| Avg             | 302              | 29    | 258     | 123   | 87    | 70    | 205     | 236   | 167   | 132   | 78*     | 298*  | 219*  | 167*  |
| *5-year average |                  |       |         |       |       |       |         |       |       |       |         |       |       |       |

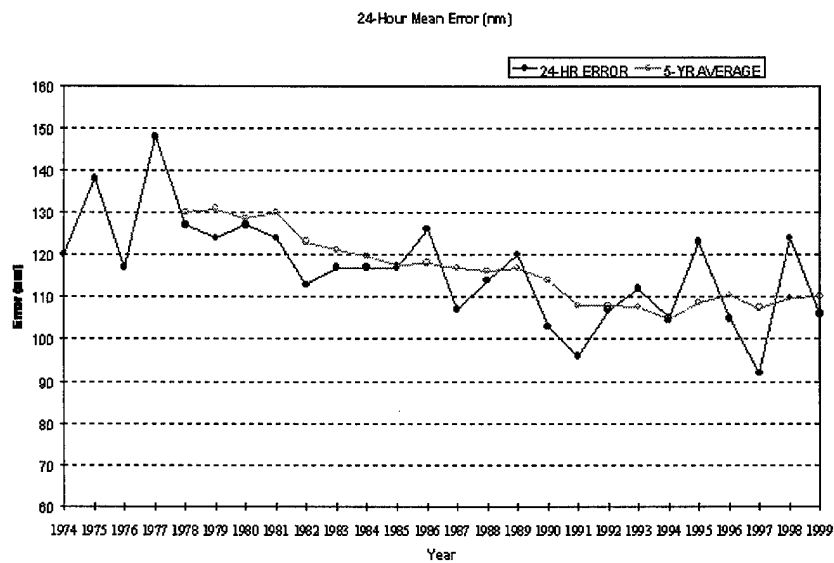


Figure 3-2a. Mean track forecast error (nm) and 5-year running mean for 24 hours for North West Pacific Ocean tropical cyclones from 1974-1999.

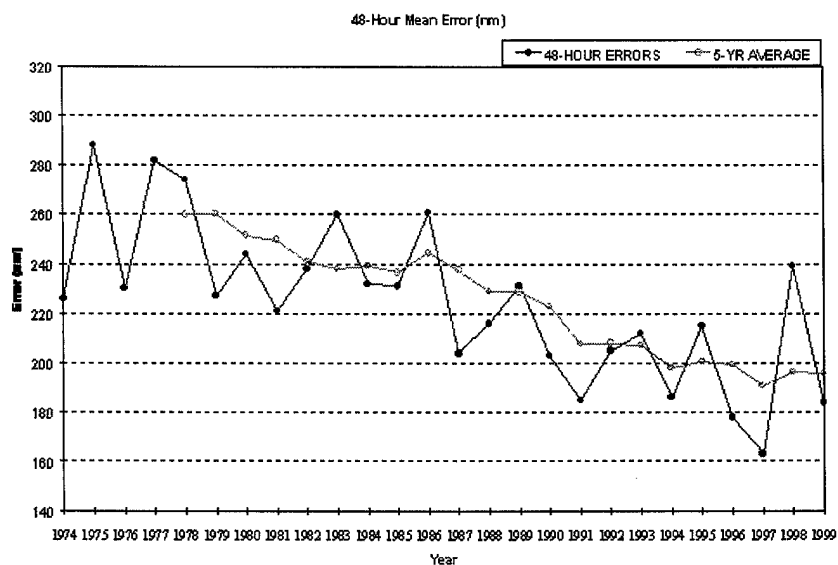


Figure 3-2b. Mean track forecast error (nm) and 5-year running mean for 48 hours for North West Pacific Ocean tropical cyclones from 1974-1999.

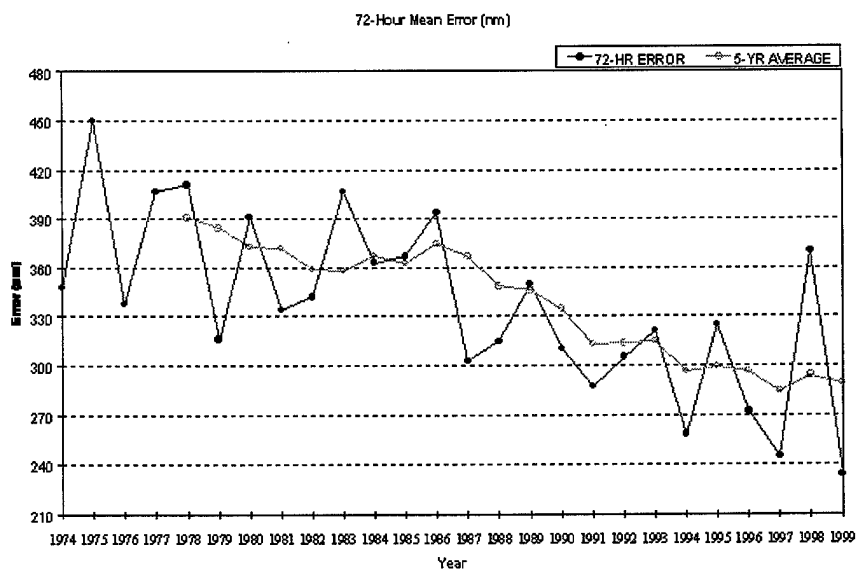


Figure 3-2c. Mean track forecast error (nm) and 5-year running mean for 72 hours for North West Pacific Ocean tropical cyclones from 1974-1999.

## 3.2 TESTING AND RESULTS

A comparison of selected techniques is included in Table 3-5 for all North West Pacific tropical cyclones, Table 3-6 for North Indian Ocean tropical cyclones and Table 3-7 for Southern Hemisphere tropical cyclones. For example, in Table 3-5 for the 12-hour mean forecast error, 212 cases were available for a homogeneous comparison. The average forecast error at 12 hours was 73 nm for NGPS and 61 nm for JTWC. The difference of 13 nm is shown in the lower right. Due to computational round-off, differences are not always exact.

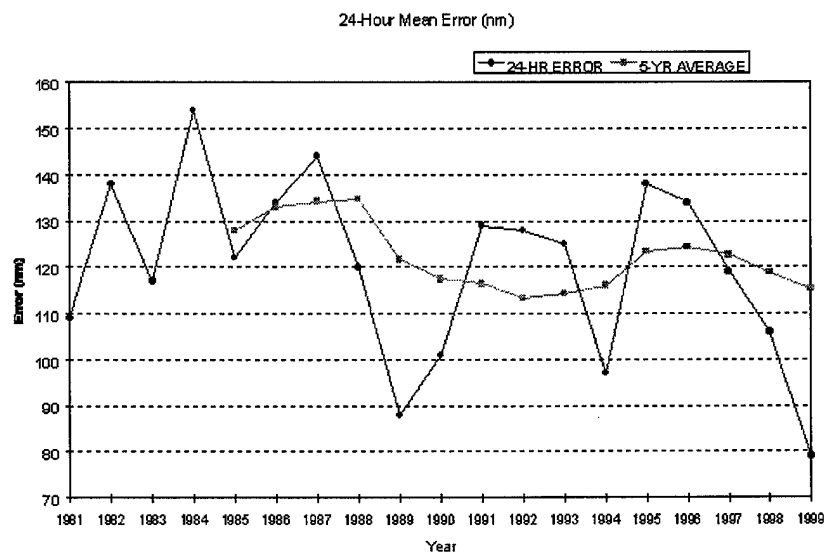


Figure 3-3a. Mean track forecast error (nm) and 5-year running mean for 24 hours for Northern Indian Ocean tropical cyclones from 1981-1999.

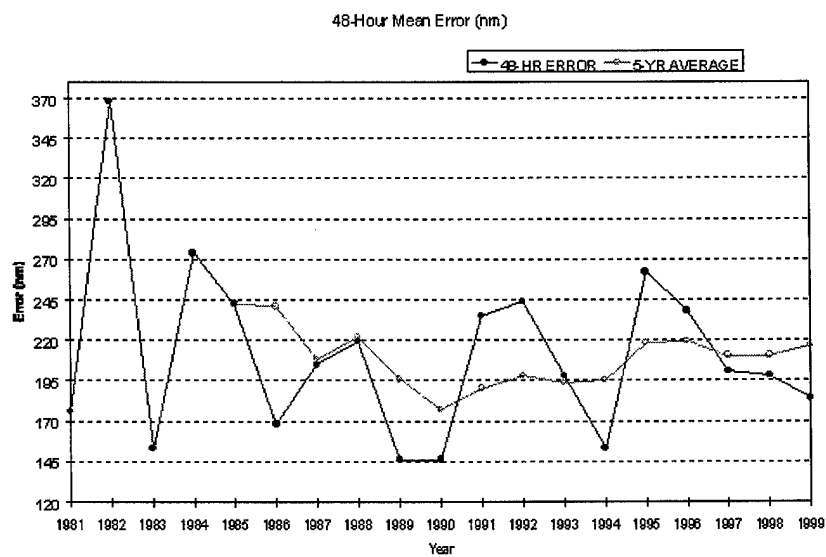


Figure 3-3b. Mean track forecast error (nm) and 5-year running mean for 48 hours, for Northern Indian Ocean tropical cyclones from 1981-1999.

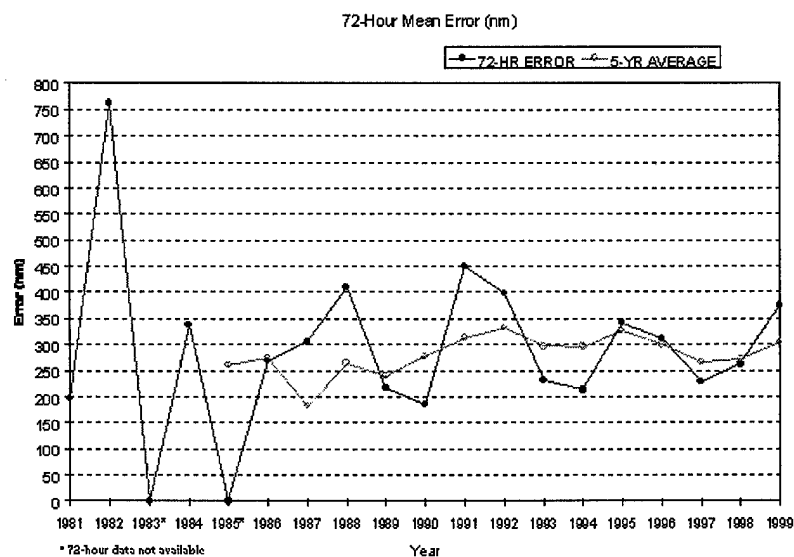


Figure 3-3c. Mean track forecast error (nm) and 5-year running mean for 72 hours for Northern Indian Ocean tropical cyclones from 1981-1999. The 1983 and 1985 zero values in the chart are due to no 72 hour forecasts during those years.

Table 3-5 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

12-HOUR MEAN FORECAST ERROR (NM)

|      | JTWC |    | NGPS |    | CSUM |     | EGRR |      | GFDN |     | JGSM |    | JTYM |    | CLIP |    |
|------|------|----|------|----|------|-----|------|------|------|-----|------|----|------|----|------|----|
| JTWC | 498  | 61 |      |    |      |     |      |      |      |     |      |    |      |    |      |    |
|      | 61   | 0  |      |    |      |     |      |      |      |     |      |    |      |    |      |    |
| NGPS | 212  | 61 | 238  | 70 |      |     |      |      |      |     |      |    |      |    |      |    |
|      | 73   | 12 | 70   | 0  |      |     |      |      |      |     |      |    |      |    |      |    |
| CSUM | 460  | 61 | 202  | 72 | 520  | 67  |      |      |      |     |      |    |      |    |      |    |
|      | 65   | 4  | 64   | -8 | 67   | 0   |      |      |      |     |      |    |      |    |      |    |
| EGRR | 0    | 0  | 5    | 34 | 1    | 102 | 6    | 83   |      |     |      |    |      |    |      |    |
|      | 0    | 0  | 42   | 8  | 290  | 188 | 83   | 0    |      |     |      |    |      |    |      |    |
| GFDN | 159  | 54 | 0    | 0  | 151  | 56  | 0    | 0    | 161  | 130 |      |    |      |    |      |    |
|      | 131  | 77 | 0    | 0  | 97   | 41  | 0    | 0    | 130  | 0   |      |    |      |    |      |    |
| JGSM | 139  | 58 | 119  | 66 | 141  | 64  | 1    | 290  | 10   | 67  | 145  | 65 |      |    |      |    |
|      | 64   | 6  | 63   | -3 | 65   | 1   | 70   | -220 | 58   | -9  | 65   | 0  |      |    |      |    |
| JTYM | 146  | 55 | 9    | 62 | 142  | 60  | 0    | 0    | 100  | 54  | 14   | 70 | 147  | 59 |      |    |
|      | 59   | 4  | 81   | 19 | 59   | -1  | 0    | 0    | 57   | 3   | 72   | 2  | 59   | 0  |      |    |
| CLIP | 497  | 61 | 237  | 70 | 520  | 67  | 6    | 83   | 161  | 130 | 144  | 65 | 147  | 59 | 633  | 67 |
|      | 66   | 5  | 64   | -6 | 69   | 2   | 39   | -44  | 58   | -72 | 67   | 2  | 63   | 4  | 67   | 0  |

Table 3-5 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

## 24-HOUR MEAN FORECAST ERROR (NM)

|      | JTCW |     | NGPS |     | CSUM |     | EGRR |     | GFDN |     | JGSM |     | JTYM |    | CLIP |     |
|------|------|-----|------|-----|------|-----|------|-----|------|-----|------|-----|------|----|------|-----|
| JTCW | 445  | 106 |      |     |      |     |      |     |      |     |      |     |      |    |      |     |
|      | 106  | 0   |      |     |      |     |      |     |      |     |      |     |      |    |      |     |
| NGPS | 191  | 104 | 218  | 115 |      |     |      |     |      |     |      |     |      |    |      |     |
|      | 120  | 16  | 115  | 0   |      |     |      |     |      |     |      |     |      |    |      |     |
| CSUM | 414  | 106 | 185  | 118 | 473  | 126 |      |     |      |     |      |     |      |    |      |     |
|      | 124  | 18  | 119  | 1   | 126  | 0   |      |     |      |     |      |     |      |    |      |     |
| EGRR | 172  | 104 | 156  | 114 | 181  | 122 | 214  | 105 |      |     |      |     |      |    |      |     |
|      | 96   | -8  | 91   | -23 | 104  | -18 | 105  | 0   |      |     |      |     |      |    |      |     |
| GFDN | 143  | 101 | 0    | 0   | 139  | 114 | 5    | 140 | 145  | 177 |      |     |      |    |      |     |
|      | 178  | 77  | 0    | 0   | 139  | 25  | 92   | -48 | 177  | 0   |      |     |      |    |      |     |
| JGSM | 128  | 97  | 111  | 109 | 131  | 116 | 103  | 92  | 9    | 116 | 136  | 92  |      |    |      |     |
|      | 88   | -9  | 89   | -20 | 91   | -25 | 91   | -1  | 75   | -41 | 92   | 0   |      |    |      |     |
| JTYM | 134  | 98  | 8    | 97  | 130  | 118 | 10   | 109 | 95   | 96  | 12   | 101 | 135  | 88 |      |     |
|      | 87   | -11 | 116  | 19  | 88   | -30 | 97   | -12 | 87   | -9  | 98   | -3  | 88   | 0  |      |     |
| CLIP | 445  | 106 | 217  | 116 | 473  | 126 | 196  | 104 | 145  | 177 | 134  | 91  | 135  | 88 | 580  | 123 |
|      | 126  | 20  | 118  | 2   | 128  | 2   | 124  | 20  | 118  | -59 | 127  | 36  | 125  | 37 | 123  | 0   |

## 36-HOUR MEAN FORECAST ERROR (NM)

|      | JTCW |     | NGPS |     | CSUM |     | EGRR |     | GFDN |     | JGSM |     | JTYM |     | CLIP |     |
|------|------|-----|------|-----|------|-----|------|-----|------|-----|------|-----|------|-----|------|-----|
| JTCW | 375  | 145 |      |     |      |     |      |     |      |     |      |     |      |     |      |     |
|      | 145  | 0   |      |     |      |     |      |     |      |     |      |     |      |     |      |     |
| NGPS | 154  | 141 | 183  | 157 |      |     |      |     |      |     |      |     |      |     |      |     |
|      | 160  | 19  | 157  | 0   |      |     |      |     |      |     |      |     |      |     |      |     |
| CSUM | 346  | 144 | 152  | 157 | 413  | 177 |      |     |      |     |      |     |      |     |      |     |
|      | 176  | 32  | 170  | 13  | 177  | 0   |      |     |      |     |      |     |      |     |      |     |
| EGRR | 0    | 0   | 5    | 105 | 0    | 0   | 5    | 116 |      |     |      |     |      |     |      |     |
|      | 0    | 0   | 116  | 11  | 0    | 0   | 116  | 0   |      |     |      |     |      |     |      |     |
| GFDN | 119  | 140 | 0    | 0   | 119  | 160 | 0    | 0   | 125  | 173 |      |     |      |     |      |     |
|      | 175  | 35  | 0    | 0   | 122  | -38 | 0    | 0   | 173  | 0   |      |     |      |     |      |     |
| JGSM | 112  | 129 | 91   | 130 | 116  | 163 | 0    | 0   | 6    | 111 | 120  | 119 |      |     |      |     |
|      | 118  | -11 | 114  | -16 | 120  | -43 | 0    | 0   | 105  | -6  | 119  | 0   |      |     |      |     |
| JTYM | 110  | 133 | 7    | 99  | 110  | 159 | 0    | 0   | 81   | 123 | 11   | 128 | 114  | 110 |      |     |
|      | 109  | -24 | 140  | 41  | 111  | -48 | 0    | 0   | 105  | -18 | 119  | -9  | 110  | 0   |      |     |
| CLIP | 375  | 145 | 182  | 157 | 413  | 177 | 5    | 116 | 125  | 173 | 119  | 120 | 114  | 110 | 518  | 183 |
|      | 186  | 41  | 173  | 16  | 188  | 11  | 95   | -21 | 177  | 4   | 186  | 66  | 188  | 78  | 183  | 0   |

Table 3-5 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

## 48-HOUR MEAN FORECAST ERROR (NM)

|      | JTCW |     | NGPS |     | CSUM |     | EGRR |     | GFDN |     | JGSM |     | JTYM |     | CLIP |     |
|------|------|-----|------|-----|------|-----|------|-----|------|-----|------|-----|------|-----|------|-----|
| JTCW | 307  | 176 |      |     |      |     |      |     |      |     |      |     |      |     |      |     |
|      | 176  | 0   |      |     |      |     |      |     |      |     |      |     |      |     |      |     |
| NGPS | 120  | 169 | 146  | 186 |      |     |      |     |      |     |      |     |      |     |      |     |
|      | 182  | 13  | 186  | 0   |      |     |      |     |      |     |      |     |      |     |      |     |
| CSUM | 281  | 175 | 119  | 185 | 351  | 220 |      |     |      |     |      |     |      |     |      |     |
|      | 217  | 42  | 212  | 27  | 220  | 0   |      |     |      |     |      |     |      |     |      |     |
| EGRR | 114  | 159 | 93   | 154 | 124  | 209 | 155  | 150 |      |     |      |     |      |     |      |     |
|      | 136  | -23 | 139  | -15 | 146  | -63 | 150  | 0   |      |     |      |     |      |     |      |     |
| GFDN | 99   | 168 | 0    | 0   | 99   | 202 | 2    | 95  | 105  | 214 |      |     |      |     |      |     |
|      | 218  | 50  | 0    | 0   | 153  | -49 | 134  | 39  | 214  | 0   |      |     |      |     |      |     |
| JGSM | 101  | 155 | 77   | 151 | 103  | 197 | 80   | 138 | 6    | 120 | 108  | 155 |      |     |      |     |
|      | 152  | -3  | 142  | -9  | 154  | -43 | 157  | 19  | 115  | -5  | 155  | 0   |      |     |      |     |
| JTYM | 96   | 166 | 5    | 98  | 95   | 202 | 7    | 123 | 70   | 156 | 9    | 127 | 98   | 138 |      |     |
|      | 138  | -28 | 134  | 36  | 139  | -63 | 177  | 54  | 136  | -20 | 139  | 12  | 138  | 0   |      |     |
| CLIP | 307  | 176 | 145  | 186 | 351  | 220 | 138  | 142 | 105  | 214 | 106  | 155 | 98   | 138 | 454  | 244 |
|      | 249  | 73  | 232  | 46  | 249  | 29  | 237  | 95  | 244  | 30  | 243  | 88  | 254  | 116 | 244  | 0   |

## 72-HOUR MEAN FORECAST ERROR (NM)

|      | JTCW |     | NGPS |     | CSUM |     | EGRR |     | GFDN |     | JGSM |     | JTYM |     | CLIP |     |
|------|------|-----|------|-----|------|-----|------|-----|------|-----|------|-----|------|-----|------|-----|
| JTCW | 197  | 234 |      |     |      |     |      |     |      |     |      |     |      |     |      |     |
|      | 234  | 0   |      |     |      |     |      |     |      |     |      |     |      |     |      |     |
| NGPS | 70   | 234 | 92   | 271 |      |     |      |     |      |     |      |     |      |     |      |     |
|      | 250  | 16  | 271  | 0   |      |     |      |     |      |     |      |     |      |     |      |     |
| CSUM | 176  | 236 | 70   | 244 | 237  | 301 |      |     |      |     |      |     |      |     |      |     |
|      | 293  | 57  | 281  | 37  | 301  | 0   |      |     |      |     |      |     |      |     |      |     |
| EGRR | 74   | 228 | 57   | 214 | 80   | 290 | 103  | 196 |      |     |      |     |      |     |      |     |
|      | 187  | -41 | 202  | -12 | 202  | -88 | 196  | 0   |      |     |      |     |      |     |      |     |
| GFDN | 61   | 204 | 0    | 0   | 62   | 287 | 1    | 97  | 66   | 237 |      |     |      |     |      |     |
|      | 226  | 22  | 0    | 0   | 237  | -50 | 23   | -74 | 237  | 0   |      |     |      |     |      |     |
| JGSM | 61   | 213 | 48   | 212 | 66   | 253 | 51   | 193 | 3    | 174 | 69   | 203 |      |     |      |     |
|      | 200  | -13 | 199  | -13 | 199  | -54 | 199  | 6   | 182  | 8   | 203  | 0   |      |     |      |     |
| JTYM | 59   | 205 | 2    | 247 | 62   | 275 | 3    | 122 | 43   | 235 | 5    | 152 | 63   | 187 |      |     |
|      | 183  | -22 | 270  | 23  | 188  | -87 | 293  | 171 | 185  | -50 | 190  | 38  | 187  | 0   |      |     |
| CLIP | 197  | 234 | 91   | 269 | 237  | 301 | 91   | 201 | 66   | 237 | 68   | 201 | 63   | 187 | 331  | 363 |
|      | 358  | 124 | 352  | 83  | 353  | 52  | 321  | 120 | 357  | 120 | 320  | 119 | 323  | 136 | 363  | 0   |



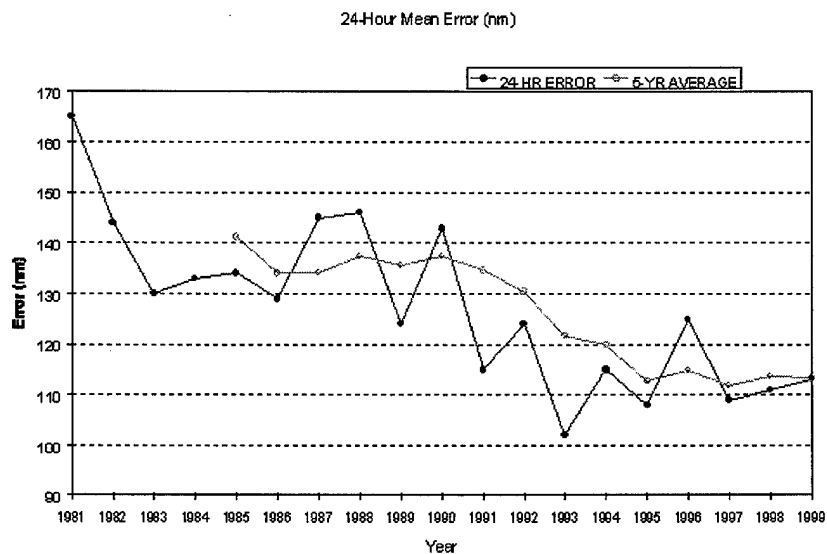


Figure 3-4a. Mean track forecast error (nm) and 5-year running mean for 24 hours for Southern Hemisphere (Africa to 180 degrees) tropical cyclones from 1981-1999.

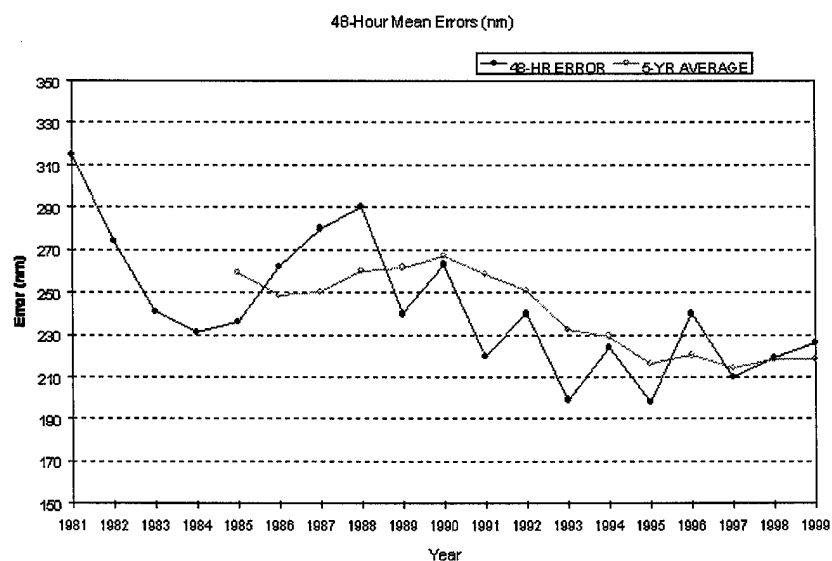


Figure 3-4b. Mean track forecast error (nm) and 5-year running mean for 48 hours for Southern Hemisphere (Africa to 180 degrees) tropical cyclones from 1981-1999.

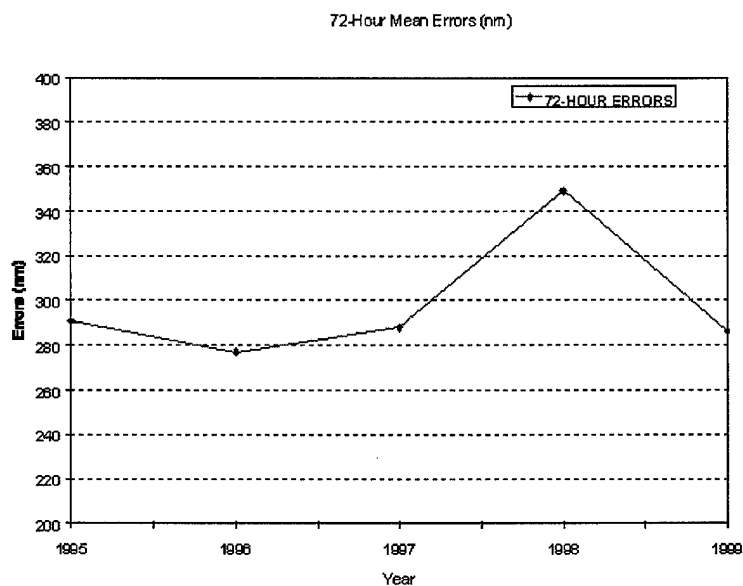


Figure 3-4c. Mean track forecast error (nm) at 72 hours for Southern Hemisphere (Africa to 180 degrees) tropical cyclones from 1995-1999.

Table 3-6 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

12-HOUR MEAN FORECAST ERROR (NM)

|      | JTWC |    | NGPS |     | GFDN |     | CLIP |    |
|------|------|----|------|-----|------|-----|------|----|
| JTWC | 47   | 39 |      |     |      |     |      |    |
|      | 39   | 0  |      |     |      |     |      |    |
| NGPS | 24   | 37 | 32   | 74  |      |     |      |    |
|      | 71   | 34 | 74   | 0   |      |     |      |    |
| GFDN | 15   | 28 | 0    | 0   | 24   | 69  |      |    |
|      | 55   | 27 | 0    | 0   | 69   | 0   |      |    |
| CLIP | 47   | 39 | 28   | 75  | 22   | 68  | 71   | 46 |
|      | 36   | -3 | 36   | -39 | 32   | -36 | 46   | 0  |

Table 3-6 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

## 24-HOUR MEAN FORECAST ERROR (NM)

|      | JTWC |    | NGPS |     | EGRR |    | GFDN |     | CLIP |    |
|------|------|----|------|-----|------|----|------|-----|------|----|
| JTWC | 41   | 79 |      |     |      |    |      |     |      |    |
|      | 79   | 0  |      |     |      |    |      |     |      |    |
| NGPS | 23   | 78 | 29   | 130 |      |    |      |     |      |    |
|      | 131  | 53 | 130  | 0   |      |    |      |     |      |    |
| EGRR | 0    | 0  | 0    | 0   | 2    | 63 |      |     |      |    |
|      | 0    | 0  | 0    | 0   | 63   | 0  |      |     |      |    |
| GFDN | 13   | 64 | 0    | 0   | 0    | 0  | 21   | 143 |      |    |
|      | 85   | 21 | 0    | 0   | 0    | 0  | 143  | 0   |      |    |
| CLIP | 41   | 79 | 26   | 130 | 0    | 0  | 19   | 138 | 65   | 91 |
|      | 75   | -4 | 70   | -60 | 0    | 0  | 68   | -70 | 91   | 0  |

## 36-HOUR MEAN FORECAST ERROR (NM)

|      | JTWC |     | NGPS |     | GFDN |     | CLIP |     |
|------|------|-----|------|-----|------|-----|------|-----|
| JTWC | 31   | 121 |      |     |      |     |      |     |
|      | 121  | 0   |      |     |      |     |      |     |
| NGPS | 17   | 117 | 25   | 165 |      |     |      |     |
|      | 155  | 38  | 165  | 0   |      |     |      |     |
| GFDN | 11   | 108 | 0    | 0   | 15   | 185 |      |     |
|      | 132  | 24  | 0    | 0   | 185  | 0   |      |     |
| CLIP | 31   | 121 | 23   | 169 | 14   | 183 | 58   | 141 |
|      | 117  | -4  | 117  | -52 | 101  | -82 | 141  | 0   |

## 48-HOUR MEAN FORECAST ERROR (NM)

|      | JTWC |     | NGPS |     | EGRR |    | GFDN |      | CLIP |     |
|------|------|-----|------|-----|------|----|------|------|------|-----|
| JTWC | 22   | 184 |      |     |      |    |      |      |      |     |
|      | 184  | 0   |      |     |      |    |      |      |      |     |
| NGPS | 12   | 176 | 21   | 205 |      |    |      |      |      |     |
|      | 164  | -12 | 205  | 0   |      |    |      |      |      |     |
| EGRR | 0    | 0   | 0    | 0   | 2    | 63 |      |      |      |     |
|      | 0    | 0   | 0    | 0   | 63   | 0  |      |      |      |     |
| GFDN | 7    | 172 | 0    | 0   | 0    | 0  | 13   | 295  |      |     |
|      | 186  | 14  | 0    | 0   | 0    | 0  | 295  | 0    |      |     |
| CLIP | 22   | 184 | 20   | 205 | 0    | 0  | 12   | 278  | 51   | 193 |
|      | 176  | -8  | 166  | -39 | 0    | 0  | 148  | -130 | 193  | 0   |

Table 3-6 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

72-HOUR MEAN FORECAST ERROR (NM)

|      | JTCW |      | NGPS |     | EGRR |    | GFDN |     | CLIP |     |
|------|------|------|------|-----|------|----|------|-----|------|-----|
| JTCW | 10   | 374  |      |     |      |    |      |     |      |     |
|      | 374  | 0    |      |     |      |    |      |     |      |     |
| NGPS | 4    | 384  | 13   | 253 |      |    |      |     |      |     |
|      | 258  | -126 | 253  | 0   |      |    |      |     |      |     |
| EGRR | 0    | 0    | 0    | 0   | 2    | 87 |      |     |      |     |
|      | 0    | 0    | 0    | 0   | 87   | 0  |      |     |      |     |
| GFDN | 5    | 342  | 0    | 0   | 0    | 0  | 8    | 408 |      |     |
|      | 269  | -73  | 0    | 0   | 0    | 0  | 408  | 0   |      |     |
| CLIP | 10   | 374  | 13   | 253 | 0    | 0  | 7    | 362 | 35   | 302 |
|      | 342  | -32  | 234  | -19 | 0    | 0  | 292  | -70 | 302  | 0   |

Table 3-7 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

12-HOUR MEAN FORECAST ERROR (NM)

|      | JTCW |     | NGPS |     | EGRR |      | GFDN |    | CLIP |     | HPAC |    |
|------|------|-----|------|-----|------|------|------|----|------|-----|------|----|
| JTCW | 343  | 61  |      |     |      |      |      |    |      |     |      |    |
|      | 61   | 0   |      |     |      |      |      |    |      |     |      |    |
| NGPS | 104  | 61  | 181  | 74  |      |      |      |    |      |     |      |    |
|      | 79   | 18  | 74   | 0   |      |      |      |    |      |     |      |    |
| EGRR | 3    | 27  | 1    | 50  | 4    | 110  |      |    |      |     |      |    |
|      | 128  | 101 | 143  | 93  | 110  | 0    |      |    |      |     |      |    |
| GFDN | 101  | 55  | 4    | 84  | 0    | 0    | 161  | 69 |      |     |      |    |
|      | 54   | -1  | 66   | -18 | 0    | 0    | 69   | 0  |      |     |      |    |
| CLIP | 340  | 61  | 134  | 76  | 3    | 128  | 131  | 62 | 495  | 127 |      |    |
|      | 79   | 18  | 103  | 27  | 24   | -104 | 81   | 19 | 127  | 0   |      |    |
| HPAC | 340  | 61  | 133  | 76  | 3    | 128  | 131  | 62 | 493  | 120 | 493  | 75 |
|      | 72   | 11  | 73   | -3  | 52   | -76  | 64   | 2  | 75   | -45 | 75   | 0  |

Table 3-7 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

## 24-HOUR MEAN FORECAST ERROR (NM)

|      | JTCW |     | NGPS |     | EGRR |     | GFDN |     | CLIP |     | HPAC |     |
|------|------|-----|------|-----|------|-----|------|-----|------|-----|------|-----|
| JTCW | 322  | 113 |      |     |      |     |      |     |      |     |      |     |
|      | 113  | 0   |      |     |      |     |      |     |      |     |      |     |
| NGPS | 100  | 115 | 172  | 119 |      |     |      |     |      |     |      |     |
|      | 126  | 11  | 119  | 0   |      |     |      |     |      |     |      |     |
| EGRR | 63   | 107 | 49   | 115 | 114  | 110 |      |     |      |     |      |     |
|      | 106  | -1  | 95   | -20 | 110  | 0   |      |     |      |     |      |     |
| GFDN | 98   | 107 | 4    | 120 | 5    | 109 | 154  | 109 |      |     |      |     |
|      | 99   | -8  | 125  | 5   | 132  | 23  | 109  | 0   |      |     |      |     |
| CLIP | 320  | 112 | 128  | 123 | 86   | 105 | 128  | 102 | 470  | 180 |      |     |
|      | 133  | 21  | 147  | 24  | 123  | 18  | 130  | 28  | 180  | 0   |      |     |
| HPAC | 320  | 112 | 128  | 123 | 86   | 105 | 128  | 102 | 469  | 175 | 469  | 137 |
|      | 134  | 22  | 136  | 13  | 133  | 28  | 124  | 22  | 137  | -38 | 137  | 0   |

## 36-HOUR MEAN FORECAST ERROR (NM)

|      | JTCW |     | NGPS |     | EGRR |     | GFDN |     | CLIP |     | HPAC |     |
|------|------|-----|------|-----|------|-----|------|-----|------|-----|------|-----|
| JTCW | 284  | 171 |      |     |      |     |      |     |      |     |      |     |
|      | 171  | 0   |      |     |      |     |      |     |      |     |      |     |
| NGPS | 85   | 181 | 150  | 160 |      |     |      |     |      |     |      |     |
|      | 171  | -10 | 160  | 0   |      |     |      |     |      |     |      |     |
| EGRR | 3    | 117 | 1    | 72  | 4    | 170 |      |     |      |     |      |     |
|      | 179  | 62  | 200  | 128 | 170  | 0   |      |     |      |     |      |     |
| GFDN | 93   | 168 | 4    | 183 | 0    | 0   | 145  | 161 |      |     |      |     |
|      | 152  | -16 | 196  | 13  | 0    | 0   | 161  | 0   |      |     |      |     |
| CLIP | 283  | 170 | 111  | 166 | 3    | 179 | 122  | 155 | 441  | 250 |      |     |
|      | 206  | 36  | 203  | 37  | 149  | -30 | 204  | 49  | 250  | 0   |      |     |
| HPAC | 280  | 166 | 110  | 165 | 3    | 179 | 122  | 155 | 438  | 248 | 438  | 205 |
|      | 196  | 30  | 208  | 43  | 162  | -17 | 192  | 37  | 205  | -43 | 205  | 0   |

Table 3-7 1999 ERROR STATISTICS FOR SELECTED OBJECTIVE TECHNIQUES

## 48-HOUR MEAN FORECAST ERROR (NM)

|      | JTCW |     | NGPS |     | EGRR |     | GFDN |     | CLIP |     | HPAC |     |
|------|------|-----|------|-----|------|-----|------|-----|------|-----|------|-----|
| JTCW | 245  | 226 |      |     |      |     |      |     |      |     |      |     |
|      | 226  | 0   |      |     |      |     |      |     |      |     |      |     |
| NGPS | 61   | 248 | 124  | 198 |      |     |      |     |      |     |      |     |
|      | 204  | -44 | 198  | 0   |      |     |      |     |      |     |      |     |
| EGRR | 47   | 187 | 34   | 180 | 98   | 234 |      |     |      |     |      |     |
|      | 187  | 0   | 158  | -22 | 234  | 0   |      |     |      |     |      |     |
| GFDN | 78   | 220 | 3    | 167 | 4    | 192 | 134  | 211 |      |     |      |     |
|      | 209  | -11 | 265  | 98  | 276  | 84  | 211  | 0   |      |     |      |     |
| CLIP | 245  | 226 | 90   | 202 | 73   | 177 | 115  | 206 | 407  | 316 |      |     |
|      | 274  | 48  | 267  | 65  | 263  | 86  | 270  | 64  | 316  | 0   |      |     |
| HPAC | 243  | 223 | 90   | 202 | 72   | 176 | 115  | 206 | 405  | 315 | 405  | 272 |
|      | 264  | 41  | 283  | 81  | 256  | 80  | 264  | 58  | 272  | -43 | 272  | 0   |

## 72-HOUR MEAN FORECAST ERROR (NM)

|      | JTCW |     | NGPS |     | EGRR |     | GFDN |     | CLIP |     | HPAC |     |
|------|------|-----|------|-----|------|-----|------|-----|------|-----|------|-----|
| JTCW | 59   | 286 |      |     |      |     |      |     |      |     |      |     |
|      | 286  | 0   |      |     |      |     |      |     |      |     |      |     |
| NGPS | 15   | 333 | 88   | 248 |      |     |      |     |      |     |      |     |
|      | 272  | -61 | 248  | 0   |      |     |      |     |      |     |      |     |
| EGRR | 11   | 261 | 26   | 259 | 79   | 261 |      |     |      |     |      |     |
|      | 180  | -81 | 278  | 19  | 261  | 0   |      |     |      |     |      |     |
| GFDN | 13   | 304 | 2    | 76  | 1    | 73  | 96   | 303 |      |     |      |     |
|      | 240  | -64 | 366  | 290 | 382  | 309 | 303  | 0   |      |     |      |     |
| CLIP | 59   | 286 | 65   | 262 | 57   | 242 | 87   | 301 | 329  | 435 |      |     |
|      | 432  | 146 | 378  | 116 | 385  | 143 | 392  | 91  | 435  | 0   |      |     |
| HPAC | 59   | 286 | 65   | 262 | 56   | 235 | 86   | 303 | 327  | 436 | 327  | 393 |
|      | 385  | 99  | 390  | 128 | 355  | 120 | 379  | 76  | 393  | -43 | 393  | 0   |

## 4. TROPICAL CYCLONE WARNING VERIFICATION STATISTICS

### 4.1 WARNING VERIFICATION STATISTICS

The verification data in this chapter includes best tracks (6-hourly positions and intensities), JTWC forecasts (12-, 24-, 36-, 48- and 72-hour position, intensity and wind radii), and fixes made from satellite, aircraft, radar, and synoptic data. These data are archived and available for download from the JTWC web page.

### 4.2 NORTH WEST PACIFIC AND NORTH INDIAN OCEAN VERIFICATION TABLES

This section includes this year's verification statistics for each North West Pacific and North Indian Ocean tropical cyclone warned on by JTWC.

| Statistics for JTWC on TS 01W Hilda |                |          |                 |    |    |     |     |     |     |             |    |    |    |    |    |    |
|-------------------------------------|----------------|----------|-----------------|----|----|-----|-----|-----|-----|-------------|----|----|----|----|----|----|
| DTG                                 | WRN BEST TRACK |          | POSITION ERRORS |    |    |     |     |     |     | WIND ERRORS |    |    |    |    |    |    |
|                                     | NO.            | LAT LONG | wind            | 00 | 12 | 24  | 36  | 48  | 72  | 00          | 12 | 24 | 36 | 48 | 72 |    |
| 99010300                            |                | 4.9N     | 113.9E          | 20 |    |     |     |     |     |             |    |    |    |    |    |    |
| 99010306                            |                | 4.9N     | 113.5E          | 20 |    |     |     |     |     |             |    |    |    |    |    |    |
| 99010312                            |                | 5.0N     | 113.2E          | 20 |    |     |     |     |     |             |    |    |    |    |    |    |
| 99010318                            |                | 5.2N     | 113.1E          | 20 |    |     |     |     |     |             |    |    |    |    |    |    |
| 99010400                            |                | 5.4N     | 113.1E          | 25 |    |     |     |     |     |             |    |    |    |    |    |    |
| 99010406                            | 1              | 5.8N     | 113.2E          | 25 | 21 | 46  | 120 | 206 | 277 | 430         | 0  | 5  | 10 | 10 | 15 | 25 |
| 99010412                            | 2              | 6.2N     | 113.2E          | 25 | 24 | 32  | 126 | 193 | 277 | 415         | 0  | 5  | 10 | 10 | 15 | 25 |
| 99010418                            | 3              | 6.6N     | 113.2E          | 25 | 26 | 111 | 194 | 264 | 341 |             | 0  | 5  | 10 | 15 | 15 |    |
| 99010500                            | 4              | 6.9N     | 113.5E          | 25 | 5  | 67  | 95  | 134 | 165 |             | 0  | 5  | 5  | 10 | 15 |    |
| 99010506                            | 5              | 7.1N     | 113.9E          | 25 | 24 | 83  | 120 | 179 | 229 |             | 5  | 5  | 10 | 10 | 20 |    |
| 99010512                            | 6              | 7.1N     | 114.3E          | 25 | 37 | 64  | 110 | 146 | 196 |             | 5  | 5  | 10 | 10 | 20 |    |
| 99010518                            | 7              | 7.3N     | 114.4E          | 30 | 34 | 47  | 100 | 135 |     |             | 0  | 0  | 0  | 10 |    |    |
| 99010600                            | 8              | 7.5N     | 114.4E          | 30 | 18 | 61  | 92  | 131 |     |             | 0  | 0  | 0  | 10 |    |    |
| 99010606                            | 9              | 7.8N     | 114.4E          | 30 | 26 | 90  | 133 |     |     |             | 5  | 5  | 10 |    |    |    |
| 99010612                            | 10             | 8.7N     | 114.3E          | 30 | 29 | 40  | 70  |     |     |             | 5  | 5  | 10 |    |    |    |
| 99010618                            | 11             | 9.1N     | 114.2E          | 35 | 29 | 48  |     |     |     |             | 0  | 10 |    |    |    |    |
| 99010700                            | 12             | 9.5N     | 114.0E          | 35 | 11 | 26  |     |     |     |             | -5 | -5 |    |    |    |    |
| 99010706                            |                | 10.0N    | 113.8E          | 30 |    |     |     |     |     |             |    |    |    |    |    |    |
| 99010712                            |                | 10.4N    | 113.5E          | 30 |    |     |     |     |     |             |    |    |    |    |    |    |
| AVERAGE                             |                |          |                 | 24 | 60 | 116 | 173 | 247 | 422 | 2           | 5  | 8  | 11 | 17 | 25 |    |

| Statistics for JTWC on TS 01W Hilda |    |    |    |   |   |   |    |    |    |    |    |    |
|-------------------------------------|----|----|----|---|---|---|----|----|----|----|----|----|
| BIAS                                |    |    |    |   |   |   |    |    |    |    |    |    |
| #                                   | 12 | 12 | 10 | 8 | 6 | 2 | 1  | 4  | 8  | 11 | 17 | 25 |
| CASES                               | 12 | 12 | 10 | 8 | 6 | 2 | 12 | 12 | 10 | 8  | 6  | 2  |

| Statistics for JTWC on TS 02W Iris |     |         |               |                 |    |     |     |     |     |    |             |    |    |    |     |    |
|------------------------------------|-----|---------|---------------|-----------------|----|-----|-----|-----|-----|----|-------------|----|----|----|-----|----|
|                                    |     | WRN     | BEST<br>TRACK | POSITION ERRORS |    |     |     |     |     |    | WIND ERRORS |    |    |    |     |    |
| DTG                                | NO. | LAT     | LONG          | wind            | 00 | 12  | 24  | 36  | 48  | 72 | 00          | 12 | 24 | 36 | 48  | 72 |
| 99021318                           |     | 11.2N   | 137.7E        | 20              |    |     |     |     |     |    |             |    |    |    |     |    |
| 99021400                           |     | 11.0N   | 137.3E        | 20              |    |     |     |     |     |    |             |    |    |    |     |    |
| 99021406                           |     | 11.0N   | 136.9E        | 20              |    |     |     |     |     |    |             |    |    |    |     |    |
| 99021412                           |     | 11.2N   | 136.5E        | 20              |    |     |     |     |     |    |             |    |    |    |     |    |
| 99021418                           |     | 11.2N   | 136.1E        | 25              |    |     |     |     |     |    |             |    |    |    |     |    |
| 99021500                           |     | 11.2N   | 135.7E        | 20              |    |     |     |     |     |    |             |    |    |    |     |    |
| 99021506                           |     | 11.3N   | 135.2E        | 20              |    |     |     |     |     |    |             |    |    |    |     |    |
| 99021512                           |     | 11.4N   | 134.6E        | 20              |    |     |     |     |     |    |             |    |    |    |     |    |
| 99021518                           |     | 11.5N   | 134.0E        | 20              |    |     |     |     |     |    |             |    |    |    |     |    |
| 99021600                           | 1   | 11.7N   | 133.3E        | 25              | 18 | 56  | 30  | 30  | 19  | 47 | 0           | 0  | 0  | 0  | 0   | 10 |
| 99021606                           | 2   | 11.8N   | 133.0E        | 25              | 18 | 46  | 111 | 118 | 85  |    | 0           | 0  | 0  | 0  | 0   |    |
| 99021612                           | 3   | 11.8N   | 132.6E        | 30              | 30 | 84  | 152 | 160 | 210 |    | 0           | -5 | -5 | -5 | -10 |    |
| 99021618                           | 4   | 11.8N   | 131.9E        | 30              | 21 | 129 | 155 | 122 | 82  |    | 0           | -5 | -5 | -5 | 0   |    |
| 99021700                           | 5   | 12.0N   | 130.7E        | 35              | 31 | 93  | 74  | 30  | 38  |    | 0           | 5  | 15 | 20 | 30  |    |
| 99021706                           | 6   | 12.3N   | 129.2E        | 35              | 26 | 48  | 80  | 89  |     |    | 0           | 10 | 20 | 15 |     |    |
| 99021712                           | 7   | 12.7N   | 128.4E        | 35              | 13 | 70  | 123 | 173 |     |    | 0           | 10 | 10 | 15 |     |    |
| 99021718                           | 8   | 13.0N   | 127.8E        | 35              | 26 | 84  | 123 |     |     |    | 0           | 5  | 5  |    |     |    |
| 99021800                           | 9   | 13.3N   | 127.4E        | 30              | 26 | 58  | 115 |     |     |    | 0           | 0  | 10 |    |     |    |
| 99021806                           | 10  | 13.6N   | 127.0E        | 30              | 0  | 0   |     |     |     |    | 0           | 5  |    |    |     |    |
| 99021812                           | 11  | 13.9N   | 126.7E        | 30              | 0  | 17  |     |     |     |    | 0           | 10 |    |    |     |    |
| 99021818                           | 12  | 14.2N   | 126.3E        | 25              | 0  |     |     |     |     |    | 0           |    |    |    |     |    |
| 99021900                           |     | 14.2N   | 126.3E        | 15              |    |     |     |     |     |    |             |    |    |    |     |    |
|                                    |     | AVERAGE |               |                 | 18 | 62  | 107 | 103 | 87  | 47 | 0           | 5  | 8  | 9  | 8   | 10 |
|                                    |     | BIAS    |               |                 |    |     |     |     |     |    | 0           | 3  | 6  | 6  | 4   | 10 |
|                                    |     | #       |               |                 | 12 | 11  | 9   | 7   | 5   | 1  | 12          | 11 | 9  | 7  | 5   | 1  |
|                                    |     | CASES   |               |                 |    |     |     |     |     |    |             |    |    |    |     |    |

| Statistics for JTWC on TS 03W Jacob |     |       |            |                 |    |     |     |     |     |     |             |    |    |    |    |    |
|-------------------------------------|-----|-------|------------|-----------------|----|-----|-----|-----|-----|-----|-------------|----|----|----|----|----|
|                                     | WRN |       | BEST TRACK | POSITION ERRORS |    |     |     |     |     |     | WIND ERRORS |    |    |    |    |    |
| DTG                                 | NO. | LAT   | LONG       | wind            | 00 | 12  | 24  | 36  | 48  | 72  | 00          | 12 | 24 | 36 | 48 | 72 |
| 99040518                            |     | 9.8N  | 135.8E     | 20              |    |     |     |     |     |     |             |    |    |    |    |    |
| 99040600                            |     | 10.3N | 134.8E     | 20              |    |     |     |     |     |     |             |    |    |    |    |    |
| 99040606                            | 1   | 10.8N | 133.9E     | 25              | 41 | 130 | 246 | 352 | 407 | 391 | 0           | 10 | 10 | 15 | 15 | -5 |
| 99040612                            | 2   | 11.3N | 133.2E     | 25              | 16 | 95  | 143 | 195 | 232 | 213 | 0           | 5  | 5  | 10 | 15 | -5 |
| 99040618                            | 3   | 12.0N | 133.1E     | 25              | 33 | 66  | 94  | 93  | 64  | 83  | 0           | 0  | 5  | 10 | 5  | 20 |
| 99040700                            | 4   | 12.6N | 133.0E     | 25              | 29 | 93  | 173 | 201 | 174 | 144 | 0           | 0  | 5  | 10 | 10 | 25 |
| 99040706                            | 5   | 12.8N | 132.8E     | 30              | 24 | 76  | 127 | 151 | 180 |     | 0           | 0  | 5  | 5  | 10 |    |
| 99040712                            | 6   | 12.9N | 132.5E     | 30              | 24 | 79  | 131 | 207 | 267 |     | -5          | 0  | 5  | 0  | -5 |    |



| Statistics for JTWC on TS 03W Jacob |    |         |        |    |    |     |     |     |     |     |    |    |    |    |    |    |
|-------------------------------------|----|---------|--------|----|----|-----|-----|-----|-----|-----|----|----|----|----|----|----|
| 99040718                            | 7  | 12.8N   | 132.4E | 30 | 18 | 72  | 138 | 216 | 234 |     | 0  | 0  | 0  | 5  | 5  |    |
| 99040800                            | 8  | 12.5N   | 131.6E | 30 | 42 | 103 | 205 | 257 | 252 |     | 0  | 5  | 5  | 0  | 10 |    |
| 99040806                            | 9  | 12.4N   | 130.8E | 30 | 21 | 67  | 138 | 148 |     |     | 0  | 0  | 5  | 5  |    |    |
| 99040812                            | 10 | 12.4N   | 129.6E | 30 | 23 | 104 | 111 | 94  |     |     | 0  | 5  | 5  | 10 |    |    |
| 99040818                            | 11 | 12.6N   | 128.4E | 35 | 13 | 78  | 77  |     |     |     | 0  | 5  | 10 |    |    |    |
| 99040900                            | 12 | 13.1N   | 126.6E | 30 | 11 | 64  | 117 |     |     |     | 0  | 0  | 5  |    |    |    |
| 99040906                            | 13 | 13.1N   | 125.6E | 30 | 11 | 26  |     |     |     |     | 0  | 0  |    |    |    |    |
| 99040918                            | 14 | 13.5N   | 123.8E | 25 | 26 |     |     |     |     |     | 0  |    |    |    |    |    |
| 99041000                            |    | 13.9N   | 123.3E | 20 |    |     |     |     |     |     |    |    |    |    |    |    |
|                                     |    | AVERAGE |        |    | 24 | 81  | 142 | 191 | 226 | 208 | 0  | 2  | 5  | 7  | 9  | 14 |
|                                     |    | BIAS    |        |    |    |     |     |     |     |     | 0  | 2  | 5  | 7  | 8  | 9  |
|                                     |    | #       |        |    | 14 | 13  | 12  | 10  | 8   | 4   | 14 | 13 | 12 | 10 | 8  | 4  |
|                                     |    | CASES   |        |    |    |     |     |     |     |     |    |    |    |    |    |    |

| Statistics for JTWC on TY 04W Kate |     |       |        |            |    |                 |     |     |     |     |     |             |     |     |     |     |  |
|------------------------------------|-----|-------|--------|------------|----|-----------------|-----|-----|-----|-----|-----|-------------|-----|-----|-----|-----|--|
|                                    |     | WRN   |        | BEST TRACK |    | POSITION ERRORS |     |     |     |     |     | WIND ERRORS |     |     |     |     |  |
| DTG                                | NO. | LAT   | LONG   | wind       | 00 | 12              | 24  | 36  | 48  | 72  | 00  | 12          | 24  | 36  | 48  | 72  |  |
| 99042100                           |     | 7.6N  | 126.1E | 20         |    |                 |     |     |     |     |     |             |     |     |     |     |  |
| 99042106                           |     | 8.1N  | 125.6E | 20         |    |                 |     |     |     |     |     |             |     |     |     |     |  |
| 99042112                           |     | 8.6N  | 125.5E | 20         |    |                 |     |     |     |     |     |             |     |     |     |     |  |
| 99042118                           |     | 9.1N  | 125.6E | 20         |    |                 |     |     |     |     |     |             |     |     |     |     |  |
| 99042200                           | 1   | 9.9N  | 125.6E | 25         | 13 | 95              | 120 | 143 | 211 | 371 | 0   | -5          | -5  | -10 | -20 | -35 |  |
| 99042206                           | 2   | 11.0N | 125.9E | 30         | 24 | 77              | 176 | 296 | 415 | 538 | 0   | 5           | 0   | -10 | -20 | -35 |  |
| 99042212                           | 3   | 12.1N | 126.3E | 30         | 39 | 118             | 229 | 357 | 430 | 470 | 0   | 0           | -5  | -15 | -20 | -35 |  |
| 99042218                           | 4   | 12.8N | 126.5E | 30         | 29 | 63              | 129 | 204 | 224 | 207 | 0   | 0           | -10 | -20 | -30 | -40 |  |
| 99042300                           | 5   | 13.4N | 126.7E | 35         | 37 | 84              | 134 | 170 | 189 | 174 | 0   | -5          | -15 | -20 | -35 | -40 |  |
| 99042306                           | 6   | 13.8N | 127.0E | 35         | 11 | 47              | 85  | 76  | 64  | 125 | 0   | -5          | -10 | -20 | -35 | -40 |  |
| 99042312                           | 7   | 14.1N | 127.5E | 40         | 11 | 26              | 21  | 25  | 46  | 127 | 0   | -5          | -10 | -25 | -35 | -45 |  |
| 99042318                           | 8   | 14.4N | 128.0E | 45         | 0  | 6               | 17  | 17  | 21  | 56  | 0   | -5          | -10 | -20 | -25 | -45 |  |
| 99042400                           | 9   | 14.7N | 128.7E | 50         | 0  | 8               | 18  | 17  | 6   | 129 | 0   | 5           | 0   | 5   | 10  | -5  |  |
| 99042406                           | 10  | 15.0N | 129.3E | 50         | 8  | 21              | 35  | 61  | 72  | 271 | 0   | 0           | 0   | 5   | 5   | -10 |  |
| 99042412                           | 11  | 15.7N | 129.8E | 50         | 8  | 19              | 64  | 59  | 78  | 254 | 0   | -5          | 0   | 0   | -10 | -20 |  |
| 99042418                           | 12  | 16.3N | 130.3E | 55         | 5  | 13              | 38  | 34  | 79  | 218 | 0   | -5          | 0   | 0   | -20 | -15 |  |
| 99042500                           | 13  | 16.9N | 130.8E | 60         | 8  | 45              | 37  | 63  | 128 | 192 | 0   | 5           | 5   | -5  | -20 | -25 |  |
| 99042506                           | 14  | 17.8N | 131.3E | 60         | 16 | 21              | 38  | 55  | 93  | 154 | 0   | 5           | 5   | -15 | -20 | -20 |  |
| 99042512                           | 15  | 18.8N | 131.9E | 60         | 0  | 69              | 150 | 142 | 168 | 148 | 0   | 0           | -10 | -20 | -25 | -20 |  |
| 99042518                           | 16  | 19.5N | 132.5E | 60         | 13 | 24              | 58  | 86  | 82  | 99  | 0   | -5          | -20 | -20 | -20 | -20 |  |
| 99042600                           | 17  | 20.0N | 133.2E | 60         | 0  | 30              | 25  | 34  | 19  | 62  | 0   | -10         | -15 | -20 | -20 | -25 |  |
| 99042606                           | 18  | 20.6N | 133.8E | 60         | 0  | 53              | 84  | 97  | 105 | 195 | -5  | -25         | -20 | -20 | -20 | -20 |  |
| 99042612                           | 19  | 21.0N | 135.0E | 65         | 0  | 69              | 70  | 91  | 106 |     | -15 | -20         | -25 | -20 | -20 |     |  |
| 99042618                           | 20  | 22.2N | 136.4E | 75         | 0  | 20              | 30  | 49  | 85  |     | -25 | -20         | -20 | -15 | -20 |     |  |
| 99042700                           | 21  | 23.2N | 138.1E | 70         | 8  | 19              | 38  | 60  | 137 |     | -10 | 0           | 5   | 0   | -5  |     |  |
| 99042706                           | 22  | 24.0N | 140.0E | 70         | 0  | 38              | 64  | 87  | 152 |     | 5   | 10          | 10  | 0   | 0   |     |  |
| 99042712                           | 23  | 25.0N | 141.6E | 70         | 21 | 66              | 69  | 70  |     |     | 0   | -5          | -5  | -10 |     |     |  |
| 99042718                           | 24  | 26.1N | 143.3E | 65         | 8  | 29              | 91  | 179 |     |     | 0   | 5           | -5  | 0   |     |     |  |
| 99042800                           | 25  | 27.2N | 145.3E | 60         | 16 | 63              | 127 |     |     |     | 0   | 0           | -5  |     |     |     |  |

| Statistics for JTWC on TY 04W Kate |    |         |        |    |    |    |     |     |     |     |    |    |    |     |     |     |
|------------------------------------|----|---------|--------|----|----|----|-----|-----|-----|-----|----|----|----|-----|-----|-----|
| 99042806                           | 26 | 28.3N   | 147.4E | 55 | 0  | 84 | 149 |     |     | 0   | -5 | 0  |    |     |     |     |
| 99042812                           | 27 | 29.3N   | 149.5E | 55 | 10 | 81 |     |     |     | -5  | -5 |    |    |     |     |     |
| 99042818                           |    | 30.1N   | 151.7E | 55 |    |    |     |     |     |     |    |    |    |     |     |     |
| 99042900                           |    | 31.0N   | 154.4E | 55 |    |    |     |     |     |     |    |    |    |     |     |     |
| 99042906                           |    | 32.0N   | 157.3E | 45 |    |    |     |     |     |     |    |    |    |     |     |     |
|                                    |    | AVERAGE |        |    | 11 | 48 | 81  | 103 | 132 | 210 | 2  | 6  | 8  | 12  | 20  | 28  |
|                                    |    | BIAS    |        |    |    |    |     |     |     |     | -2 | -4 | -6 | -11 | -18 | -28 |
|                                    |    | #       |        |    | 27 | 27 | 26  | 24  | 22  | 18  | 27 | 27 | 26 | 24  | 22  | 18  |
|                                    |    | CASES   |        |    |    |    |     |     |     |     |    |    |    |     |     |     |

| Statistics for JTWC on TY 05W Leo |     |         |        |                 |    |     |     |     |     |     |             |     |     |     |     |     |
|-----------------------------------|-----|---------|--------|-----------------|----|-----|-----|-----|-----|-----|-------------|-----|-----|-----|-----|-----|
|                                   |     | WRN     | BEST   | POSITION ERRORS |    |     |     |     |     |     | WIND ERRORS |     |     |     |     |     |
| DTG                               | NO. | LAT     | LONG   | wind            | 00 | 12  | 24  | 36  | 48  | 72  | 00          | 12  | 24  | 36  | 48  | 72  |
| 99042518                          |     | 14.2N   | 114.0E | 15              |    |     |     |     |     |     |             |     |     |     |     |     |
| 99042600                          |     | 14.5N   | 114.0E | 15              |    |     |     |     |     |     |             |     |     |     |     |     |
| 99042606                          |     | 14.8N   | 113.9E | 15              |    |     |     |     |     |     |             |     |     |     |     |     |
| 99042612                          |     | 15.1N   | 113.7E | 20              |    |     |     |     |     |     |             |     |     |     |     |     |
| 99042618                          |     | 15.4N   | 113.4E | 20              |    |     |     |     |     |     |             |     |     |     |     |     |
| 99042700                          | 1   | 15.7N   | 112.9E | 25 1            | 20 | 138 | 163 | 151 | 87  | 120 | 0           | 0   | -5  | -5  | -5  | -45 |
| 99042706                          | 2   | 15.9N   | 112.5E | 25 1            | 16 | 136 | 141 | 96  | 62  | 139 | 0           | 0   | -10 | -5  | -15 | -60 |
| 99042712                          | 3   | 16.0N   | 111.9E | 25 1            | 44 | 164 | 127 | 27  | 71  | 155 | 0           | -5  | -10 | -5  | -25 | -65 |
| 99042718                          | 4   | 15.8N   | 111.3E | 25              | 57 | 101 | 66  | 97  | 162 | 252 | 0           | -10 | -10 | -15 | -35 | -75 |
| 99042800                          | 5   | 15.6N   | 110.9E | 30              | 54 | 72  | 113 | 192 | 246 | 328 | 0           | -5  | 0   | -15 | -35 | -40 |
| 99042806                          | 6   | 15.2N   | 110.9E | 35              | 46 | 160 | 306 | 407 | 498 |     | 0           | 0   | -15 | -40 | -80 |     |
| 99042812                          | 7   | 15.3N   | 111.2E | 35              | 81 | 204 | 320 | 410 | 501 |     | 0           | 5   | -15 | -50 | -85 |     |
| 99042818                          | 8   | 15.8N   | 111.9E | 35              | 42 | 123 | 166 | 206 | 234 | 226 | 0           | -10 | -30 | -60 | -70 | -20 |
| 99042900                          | 9   | 16.3N   | 112.7E | 35              | 13 | 63  | 79  | 114 | 141 | 127 | 0           | -20 | -45 | -65 | -50 | -5  |
| 99042906                          | 10  | 17.3N   | 113.3E | 45              | 6  | 66  | 107 | 145 | 165 | 164 | 0           | -15 | -45 | -55 | -40 | -20 |
| 99042912                          | 11  | 17.8N   | 113.8E | 55              | 12 | 54  | 87  | 115 | 117 | 111 | 0           | -15 | -35 | -15 | 0   | 20  |
| 99042918                          | 12  | 18.1N   | 114.2E | 65              | 11 | 23  | 46  | 45  | 51  | 67  | 0           | -30 | -35 | -20 | -10 | 35  |
| 99043000                          | 13  | 18.5N   | 114.6E | 80              | 5  | 23  | 34  | 34  | 64  | 96  | 0           | -15 | -10 | 5   | 15  | 15  |
| 99043006                          | 14  | 19.0N   | 114.9E | 100             | 5  | 29  | 29  | 42  | 77  |     | 0           | 0   | 30  | 35  | 35  |     |
| 99043012                          | 15  | 19.5N   | 115.2E | 105             | 5  | 23  | 32  | 58  | 85  |     | 0           | 20  | 40  | 40  | 45  |     |
| 99043018                          | 16  | 19.9N   | 115.5E | 110             | 6  | 25  | 62  | 98  | 102 |     | 0           | 20  | 35  | 35  | 15  |     |
| 99050100                          | 17  | 20.5N   | 115.6E | 90              | 5  | 45  | 90  | 98  | 105 |     | 0           | -10 | 0   | 10  | 5   |     |
| 99050106                          | 18  | 20.7N   | 115.5E | 85              | 5  | 25  | 62  | 73  |     |     | 0           | -5  | 0   | 20  |     |     |
| 99050112                          | 19  | 21.0N   | 115.4E | 70              | 11 | 39  | 51  | 58  |     |     | 0           | 5   | 15  | 15  |     |     |
| 99050118                          | 20  | 21.3N   | 115.2E | 65              | 25 | 62  | 61  |     |     |     | 0           | 5   | 20  |     |     |     |
| 99050200                          | 21  | 21.6N   | 114.8E | 50              | 0  | 53  | 94  |     |     |     | 0           | 10  | 20  |     |     |     |
| 99050206                          | 22  | 21.9N   | 114.7E | 50              | 0  | 33  |     |     |     |     | 0           | 20  |     |     |     |     |
| 99050212                          | 23  | 22.4N   | 114.7E | 30              | 6  | 13  |     |     |     |     | 0           | 10  |     |     |     |     |
| 99050218                          | 24  | 22.7N   | 114.7E | 20              | 0  |     |     |     |     |     | 0           |     |     |     |     |     |
| 99050300                          |     | 23.3N   | 114.6E | 15              |    |     |     |     |     |     |             |     |     |     |     |     |
|                                   |     | AVERAGE |        |                 | 33 | 73  | 106 | 130 | 163 | 162 | 0           | 10  | 20  | 27  | 33  | 36  |
|                                   |     | BIAS    |        |                 |    |     |     |     |     |     | 0           | -2  | -5  | -10 | -20 | -24 |
|                                   |     | #       |        |                 | 24 | 23  | 21  | 19  | 17  | 11  | 24          | 23  | 21  | 19  | 17  | 11  |
|                                   |     | CASES   |        |                 |    |     |     |     |     |     |             |     |     |     |     |     |

| Statistics for JTWC on TY 06W Maggie |                |       |                 |      |    |    |     |     |     |             |    |     |     |     |     |     |
|--------------------------------------|----------------|-------|-----------------|------|----|----|-----|-----|-----|-------------|----|-----|-----|-----|-----|-----|
| DTG                                  | WRN BEST TRACK |       | POSITION ERRORS |      |    |    |     |     |     | WIND ERRORS |    |     |     |     |     |     |
|                                      | NO.            | LAT   | LONG            | wind | 00 | 12 | 24  | 36  | 48  | 72          | 00 | 12  | 24  | 36  | 48  | 72  |
| 99053012                             |                | 9.3N  | 131.8E          | 20   |    |    |     |     |     |             |    |     |     |     |     |     |
| 99053018                             |                | 9.6N  | 131.8E          | 20   |    |    |     |     |     |             |    |     |     |     |     |     |
| 99053100                             |                | 9.9N  | 131.8E          | 20   |    |    |     |     |     |             |    |     |     |     |     |     |
| 99053106                             |                | 10.2N | 131.7E          | 20   |    |    |     |     |     |             |    |     |     |     |     |     |
| 99053112                             |                | 10.4N | 131.6E          | 20   |    |    |     |     |     |             |    |     |     |     |     |     |
| 99053118                             |                | 10.6N | 131.5E          | 20   |    |    |     |     |     |             |    |     |     |     |     |     |
| 99060100                             |                | 10.9N | 131.4E          | 20   |    |    |     |     |     |             |    |     |     |     |     |     |
| 99060106                             | 1              | 11.2N | 131.2E          | 25   | 21 | 72 | 130 | 172 | 227 | 376         | 0  | 0   | -15 | -30 | -20 | -35 |
| 99060112                             | 2              | 11.5N | 130.9E          | 25   | 21 | 64 | 92  | 113 | 149 | 249         | 0  | -15 | -20 | -20 | -20 | -25 |
| 99060118                             | 3              | 11.9N | 130.4E          | 25   | 11 | 60 | 85  | 103 | 129 | 197         | 0  | -15 | -30 | -20 | -25 | -25 |
| 99060200                             | 4              | 12.6N | 130.0E          | 45   | 0  | 40 | 59  | 78  | 135 | 301         | 0  | -5  | -10 | -10 | -15 | -15 |
| 99060206                             | 5              | 13.1N | 129.8E          | 45   | 13 | 36 | 42  | 58  | 145 | 181         | 0  | -15 | -10 | -15 | -25 | -10 |
| 99060212                             | 6              | 13.5N | 129.5E          | 55   | 0  | 33 | 6   | 60  | 124 | 206         | 0  | 0   | 0   | 0   | 0   | 5   |
| 99060218                             | 7              | 14.2N | 129.4E          | 65   | 0  | 21 | 86  | 150 | 174 | 238         | 0  | 10  | 10  | 0   | 15  | 20  |
| 99060300                             | 8              | 14.9N | 129.3E          | 65   | 0  | 39 | 104 | 151 | 171 | 251         | 0  | 0   | 0   | 0   | 10  | 30  |
| 99060306                             | 9              | 15.5N | 129.0E          | 65   | 0  | 29 | 66  | 88  | 82  | 218         | 0  | -5  | -10 | 0   | 15  | 35  |
| 99060312                             | 10             | 16.0N | 128.5E          | 75   | 13 | 21 | 26  | 23  | 70  | 255         | 0  | -5  | -5  | 0   | 15  | 45  |
| 99060318                             | 11             | 16.8N | 127.8E          | 80   | 5  | 38 | 54  | 23  | 87  | 259         | -5 | -15 | -10 | 0   | 15  | 55  |
| 99060400                             | 12             | 17.1N | 127.1E          | 90   | 11 | 32 | 18  | 45  | 122 | 229         | 0  | -5  | -5  | 5   | 25  | 85  |
| 99060406                             | 13             | 17.4N | 126.4E          | 100  | 0  | 23 | 62  | 106 | 185 | 219         | 0  | 5   | 10  | 15  | 30  | 85  |
| 99060412                             | 14             | 17.7N | 125.9E          | 100  | 13 | 59 | 130 | 215 | 291 | 294         | 0  | 0   | 10  | 25  | 35  | 85  |
| 99060418                             | 15             | 18.1N | 125.3E          | 100  | 0  | 62 | 124 | 213 | 288 | 235         | 0  | 5   | 10  | 30  | 50  | 85  |
| 99060500                             | 16             | 18.9N | 124.5E          | 105  | 0  | 25 | 107 | 181 | 221 | 145         | 0  | 10  | 25  | 40  | 85  | 95  |
| 99060506                             | 17             | 19.7N | 123.6E          | 100  | 0  | 18 | 65  | 110 | 109 | 132         | 0  | 0   | 15  | 40  | 70  | 25  |
| 99060512                             | 18             | 20.4N | 122.4E          | 100  | 6  | 21 | 62  | 116 | 80  |             | 0  | 5   | 10  | 30  | 15  |     |
| 99060518                             | 19             | 21.0N | 121.0E          | 100  | 0  | 53 | 94  | 98  | 50  |             | 0  | 10  | 25  | 30  | 15  |     |
| 99060600                             | 20             | 22.0N | 119.7E          | 90   | 12 | 47 | 138 | 180 | 172 |             | 0  | 5   | 25  | -5  | 5   |     |
| 99060606                             | 21             | 22.5N | 118.2E          | 85   | 0  | 45 | 103 |     |     |             | 0  | 5   | 10  |     |     |     |
| 99060612                             | 22             | 22.8N | 116.4E          | 80   | 0  | 85 | 104 |     |     |             | 0  | 15  | -5  |     |     |     |
| 99060618                             | 23             | 22.7N | 114.7E          | 65   | 0  | 58 | 73  |     |     |             | 0  | 10  | -10 |     |     |     |
| 99060700                             | 24             | 22.2N | 113.2E          | 35   | 12 | 67 |     |     |     |             | -5 | -10 |     |     |     |     |
| 99060706                             |                | 21.7N | 112.5E          | 35   |    |    |     |     |     |             |    |     |     |     |     |     |
| 99060712                             |                | 21.8N | 111.7E          | 30   |    |    |     |     |     |             |    |     |     |     |     |     |
| 99060718                             |                | 22.1N | 111.5E          | 30   |    |    |     |     |     |             |    |     |     |     |     |     |
| 99060800                             |                | 22.8N | 111.4E          | 25   |    |    |     |     |     |             |    |     |     |     |     |     |
| 99060806                             |                | 23.6N | 111.0E          | 20   |    |    |     |     |     |             |    |     |     |     |     |     |
| AVERAGE                              |                |       |                 |      | 6  | 44 | 80  | 114 | 151 | 234         | 0  | 7   | 12  | 16  | 25  | 45  |
| BIAS                                 |                |       |                 |      |    |    |     |     |     |             | 0  | 0   | 1   | 6   | 15  | 32  |
| # CASES                              |                |       |                 |      | 24 | 24 | 23  | 20  | 20  | 17          | 24 | 24  | 23  | 20  | 20  | 17  |

| Statistics for JTWC on TD 07W |                |     |                 |      |    |    |    |    |    |             |    |    |    |    |    |    |
|-------------------------------|----------------|-----|-----------------|------|----|----|----|----|----|-------------|----|----|----|----|----|----|
| DTG                           | WRN BEST TRACK |     | POSITION ERRORS |      |    |    |    |    |    | WIND ERRORS |    |    |    |    |    |    |
|                               | NO.            | LAT | LONG            | wind | 00 | 12 | 24 | 36 | 48 | 72          | 00 | 12 | 24 | 36 | 48 | 72 |

| Statistics for JTWC on TD 07W |     |       |         |      |    |     |     |     |     |     |    |    |    |    |    |    |
|-------------------------------|-----|-------|---------|------|----|-----|-----|-----|-----|-----|----|----|----|----|----|----|
| DTG                           | NO. | LAT   | LONG    | wind | 00 | 12  | 24  | 36  | 48  | 72  | 00 | 12 | 24 | 36 | 48 | 72 |
| 99071400                      |     | 24.4N | 155.9E  | 15   |    |     |     |     |     |     |    |    |    |    |    |    |
| 99071406                      |     | 24.3N | 155.5E  | 25   |    |     |     |     |     |     |    |    |    |    |    |    |
| 99071412                      |     | 24.2N | 155.1E  | 25   |    |     |     |     |     |     |    |    |    |    |    |    |
| 99071418                      |     | 24.1N | 154.7E  | 25   |    |     |     |     |     |     |    |    |    |    |    |    |
| 99071500                      | 1   | 24.1N | 154.3E  | 25 1 | 53 | 170 | 159 | 247 | 347 | 424 | 0  | 0  | 0  | 5  | 10 | 25 |
| 99071506                      | 2   | 24.0N | 153.8E  | 25   | 66 | 73  | 118 | 219 | 301 | 346 | 0  | 0  | 0  | 5  | 15 | 35 |
| 99071512                      | 3   | 24.3N | 153.4E  | 30   | 65 | 41  | 156 | 251 | 304 | 308 | 0  | 5  | 10 | 15 | 25 | 25 |
| 99071518                      | 4   | 24.4N | 152.6E  | 30   | 18 | 98  | 188 | 253 | 269 | 223 | 0  | 5  | 10 | 20 | 25 | 30 |
| 99071600                      | 5   | 24.4N | 151.5E  | 30   | 0  | 80  | 146 | 180 | 194 | 141 | 0  | 5  | 10 | 25 | 25 | 30 |
| 99071606                      | 6   | 24.8N | 149.9E  | 30   | 8  | 44  | 91  | 150 | 184 | 102 | 0  | 5  | 10 | 20 | 30 | 30 |
| 99071612                      | 7   | 25.6N | 148.6E  | 30   | 39 | 93  | 127 | 146 | 157 |     | 0  | 0  | 10 | 15 | 20 |    |
| 99071618                      | 8   | 26.3N | 147.3E  | 30   | 5  | 24  | 68  | 120 | 128 |     | 0  | 0  | 10 | 20 | 25 |    |
| 99071700                      | 9   | 26.9N | 145.9E  | 30   | 0  | 42  | 115 | 138 | 129 |     | 0  | 5  | 5  | 10 | 10 |    |
| 99071706                      | 10  | 27.3N | 144.7E  | 30   | 0  | 12  | 42  | 62  | 145 |     | 0  | 5  | 10 | 15 | 10 |    |
| 99071712                      | 11  | 27.9N | 143.7E  | 25   | 8  | 43  | 50  | 61  |     |     | 0  | 0  | 5  | 10 |    |    |
| 99071718                      | 12  | 28.4N | 143.1E  | 25   | 18 | 30  | 31  | 138 |     |     | 0  | 5  | 10 | 5  |    |    |
| 99071800                      | 13  | 29.0N | 142.6E  | 25   | 15 | 86  | 152 |     |     |     | 0  | 5  | 5  |    |    |    |
| 99071806                      | 14  | 29.9N | 142.5E  | 20   | 13 | 85  | 213 |     |     |     | 0  | 5  | 0  |    |    |    |
| 99071812                      |     | 31.2N | 142.3E  | 20   |    |     |     |     |     |     |    |    |    |    |    |    |
| 99071818                      |     | 32.4N | 142.4E  | 15   |    |     |     |     |     |     |    |    |    |    |    |    |
| 99071900                      |     | 33.8N | 143.0E  | 15   |    |     |     |     |     |     |    |    |    |    |    |    |
| 99071906                      |     | 35.6N | 144.1E  | 15   |    |     |     |     |     |     |    |    |    |    |    |    |
|                               |     |       | AVERAGE |      | 30 | 66  | 118 | 164 | 216 | 257 | 0  | 3  | 7  | 14 | 20 | 29 |
|                               |     |       | BIAS    |      |    |     |     |     |     |     | 0  | 3  | 7  | 14 | 20 | 29 |
|                               |     |       | # CASES |      | 14 | 14  | 14  | 12  | 10  | 6   | 14 | 14 | 14 | 12 | 10 | 6  |

| Statistics for JTWC on TD 08W |     |       |            |                 |    |     |     |     |     |    |             |     |     |     |     |    |
|-------------------------------|-----|-------|------------|-----------------|----|-----|-----|-----|-----|----|-------------|-----|-----|-----|-----|----|
|                               |     | WRN   | BEST TRACK | POSITION ERRORS |    |     |     |     |     |    | WIND ERRORS |     |     |     |     |    |
| DTG                           | NO. | LAT   | LONG       | wind            | 00 | 12  | 24  | 36  | 48  | 72 | 00          | 12  | 24  | 36  | 48  | 72 |
| 99071912                      |     | 24.6N | 134.0E     | 20              |    |     |     |     |     |    |             |     |     |     |     |    |
| 99071918                      |     | 25.4N | 134.0E     | 20              |    |     |     |     |     |    |             |     |     |     |     |    |
| 99072000                      |     | 26.1N | 133.7E     | 20              |    |     |     |     |     |    |             |     |     |     |     |    |
| 99072006                      |     | 27.0N | 133.2E     | 20              |    |     |     |     |     |    |             |     |     |     |     |    |
| 99072012                      |     | 27.7N | 132.4E     | 20              |    |     |     |     |     |    |             |     |     |     |     |    |
| 99072018                      |     | 28.3N | 131.5E     | 20              |    |     |     |     |     |    |             |     |     |     |     |    |
| 99072100                      |     | 28.8N | 130.5E     | 20              |    |     |     |     |     |    |             |     |     |     |     |    |
| 99072106                      | 1   | 29.3N | 129.4E     | 25              | 0  | 32  | 103 | 246 | 458 |    | 0           | -5  | 0   | 5   | -5  |    |
| 99072112                      | 2   | 29.9N | 128.5E     | 25              | 0  | 75  | 139 | 407 | 614 |    | 0           | -5  | 10  | -5  | -10 |    |
| 99072118                      | 3   | 30.7N | 127.7E     | 30              | 0  | 78  | 198 | 364 | 500 |    | -5          | 0   | 5   | -10 | -10 |    |
| 99072200                      | 4   | 32.4N | 127.5E     | 30              | 0  | 27  | 149 | 234 |     |    | 0           | 5   | -10 | -10 |     |    |
| 99072206                      | 5   | 33.7N | 126.8E     | 30              | 0  | 106 | 286 | 385 |     |    | 0           | 5   | -10 | -10 |     |    |
| 99072212                      | 6   | 35.0N | 126.9E     | 20              | 0  | 200 | 306 |     |     |    | 5           | -10 | -10 |     |     |    |
| 99072218                      |     | 36.8N | 129.1E     | 20              |    |     |     |     |     |    |             |     |     |     |     |    |
| 99072300                      |     | 38.4N | 132.3E     | 30              |    |     |     |     |     |    |             |     |     |     |     |    |

| Statistics for JTWC on TD 08W |         |        |    |     |     |     |   |    |    |    |
|-------------------------------|---------|--------|----|-----|-----|-----|---|----|----|----|
| 99072306                      | 40.1N   | 134.6E | 30 |     |     |     |   |    |    |    |
| 99072312                      | 42.7N   | 137.4E | 30 |     |     |     |   |    |    |    |
| 99072318                      | 44.4N   | 139.2E | 30 |     |     |     |   |    |    |    |
|                               | AVERAGE | 0      | 86 | 197 | 327 | 524 | 2 | 5  | 8  | 8  |
|                               | BIAS    |        |    |     |     |     | 0 | -2 | -3 | -6 |
|                               | #       | 6      | 6  | 6   | 5   | 3   | 6 | 6  | 6  | 5  |
|                               | CASES   |        |    |     |     |     |   |    |    | 3  |

| Statistics for JTWC on TS 09W Neil |                |       |                 |      |    |    |     |     |     |             |    |     |     |    |    |    |
|------------------------------------|----------------|-------|-----------------|------|----|----|-----|-----|-----|-------------|----|-----|-----|----|----|----|
| DTG                                | WRN BEST TRACK |       | POSITION ERRORS |      |    |    |     |     |     | WIND ERRORS |    |     |     |    |    |    |
|                                    | NO.            | LAT   | LONG            | wind | 00 | 12 | 24  | 36  | 48  | 72          | 00 | 12  | 24  | 36 | 48 | 72 |
| 99072318                           |                | 18.3N | 123.5E          | 20   |    |    |     |     |     |             |    |     |     |    |    |    |
| 99072400                           |                | 18.7N | 124.1E          | 20   |    |    |     |     |     |             |    |     |     |    |    |    |
| 99072406                           |                | 19.4N | 124.8E          | 20   |    |    |     |     |     |             |    |     |     |    |    |    |
| 99072412                           |                | 20.4N | 125.2E          | 20   |    |    |     |     |     |             |    |     |     |    |    |    |
| 99072418                           |                | 21.3N | 126.1E          | 20   |    |    |     |     |     |             |    |     |     |    |    |    |
| 99072500                           |                | 22.2N | 127.0E          | 20   |    |    |     |     |     |             |    |     |     |    |    |    |
| 99072506                           | 1              | 23.3N | 127.8E          | 25   | 28 | 62 | 79  | 118 | 165 | 235         | 0  | 5   | 0   | 5  | 10 | 15 |
| 99072512                           | 2              | 24.1N | 128.6E          | 30   | 20 | 87 | 117 | 168 | 185 | 294         | 0  | 5   | 5   | 10 | 15 | 10 |
| 99072518                           | 3              | 26.2N | 128.2E          | 30   | 13 | 90 | 123 | 173 | 221 |             | 0  | -10 | -10 | -5 | 0  |    |
| 99072600                           | 4              | 27.5N | 128.8E          | 35   | 13 | 30 | 97  | 118 | 157 |             | 0  | 0   | 5   | 10 | 10 |    |
| 99072606                           | 5              | 28.9N | 128.8E          | 40   | 5  | 30 | 76  | 94  | 199 |             | 0  | 0   | 5   | 5  | 10 |    |
| 99072612                           | 6              | 30.4N | 128.4E          | 40   | 18 | 90 | 96  | 116 | 233 |             | 0  | 5   | 10  | 10 | 10 |    |
| 99072618                           | 7              | 32.0N | 127.9E          | 40   | 6  | 35 | 65  | 163 |     |             | 0  | 5   | 5   | 10 |    |    |
| 99072700                           | 8              | 33.7N | 127.3E          | 35   | 6  | 32 | 94  | 229 |     |             | 0  | 5   | 5   | 5  |    |    |
| 99072706                           | 9              | 34.7N | 126.9E          | 30   | 18 | 34 | 123 |     |     |             | 0  | -5  | 0   |    |    |    |
| 99072712                           | 10             | 35.8N | 126.5E          | 25   | 0  | 64 | 184 |     |     |             | 0  | 0   | 0   |    |    |    |
| 99072718                           | 11             | 36.5N | 126.2E          | 25   | 0  | 60 |     |     |     |             | 0  | 5   |     |    |    |    |
| 99072800                           | 12             | 37.1N | 126.4E          | 20   | 7  | 73 |     |     |     |             | 5  | 5   |     |    |    |    |
| 99072806                           | 13             | 37.3N | 126.8E          | 15   | 7  |    |     |     |     |             | 0  |     |     |    |    |    |
| 99072812                           |                | 37.5N | 127.9E          | 15   |    |    |     |     |     |             |    |     |     |    |    |    |
| AVERAGE                            |                |       |                 |      | 11 | 57 | 105 | 148 | 193 | 264         | 0  | 4   | 5   | 8  | 9  | 13 |
| BIAS                               |                |       |                 |      |    |    |     |     |     |             | 0  | 2   | 3   | 6  | 9  | 13 |
| # CASES                            |                |       |                 |      | 13 | 12 | 10  | 8   | 6   | 2           | 13 | 12  | 10  | 8  | 6  | 2  |

| Statistics for JTWC on TD 10W |                |       |                 |      |    |    |    |    |    |             |    |    |    |    |    |    |
|-------------------------------|----------------|-------|-----------------|------|----|----|----|----|----|-------------|----|----|----|----|----|----|
| DTG                           | WRN BEST TRACK |       | POSITION ERRORS |      |    |    |    |    |    | WIND ERRORS |    |    |    |    |    |    |
|                               | NO.            | LAT   | LONG            | wind | 00 | 12 | 24 | 36 | 48 | 72          | 00 | 12 | 24 | 36 | 48 | 72 |
| 99072300                      |                | 16.0N | 116.6E          | 15   |    |    |    |    |    |             |    |    |    |    |    |    |
| 99072306                      |                | 16.3N | 116.9E          | 20   |    |    |    |    |    |             |    |    |    |    |    |    |
| 99072312                      |                | 16.8N | 117.2E          | 20   |    |    |    |    |    |             |    |    |    |    |    |    |
| 99072318                      |                | 17.3N | 117.4E          | 20   |    |    |    |    |    |             |    |    |    |    |    |    |
| 99072400                      |                | 17.7N | 117.2E          | 20   |    |    |    |    |    |             |    |    |    |    |    |    |
| 99072406                      |                | 18.2N | 116.5E          | 20   |    |    |    |    |    |             |    |    |    |    |    |    |
| 99072412                      |                | 18.2N | 115.5E          | 20   |    |    |    |    |    |             |    |    |    |    |    |    |
| 99072418                      |                | 18.0N | 114.3E          | 20   |    |    |    |    |    |             |    |    |    |    |    |    |
| 99072500                      |                | 18.0N | 113.6E          | 20   |    |    |    |    |    |             |    |    |    |    |    |    |
| 99072506                      |                | 18.2N | 113.3E          | 20   |    |    |    |    |    |             |    |    |    |    |    |    |
| 99072512                      |                | 18.5N | 113.2E          | 20   |    |    |    |    |    |             |    |    |    |    |    |    |
| 99072518                      |                | 18.9N | 113.2E          | 25   |    |    |    |    |    |             |    |    |    |    |    |    |
| 99072600                      |                | 19.4N | 113.3E          | 25   |    |    |    |    |    |             |    |    |    |    |    |    |
| 99072606                      |                | 19.9N | 113.4E          | 25   |    |    |    |    |    |             |    |    |    |    |    |    |
| 99072612                      |                | 20.2N | 113.5E          | 25   |    |    |    |    |    |             |    |    |    |    |    |    |

| Statistics for JTWC on TD 10W |   |         |        |    |   |     |     |   |      |
|-------------------------------|---|---------|--------|----|---|-----|-----|---|------|
| 99072618                      | 1 | 20.5N   | 113.7E | 25 | 0 | 101 | 324 | 0 | 5 15 |
| 99072700                      | 2 | 21.3N   | 114.5E | 25 | 0 | 175 |     | 0 | 10   |
| 99072706                      | 3 | 22.6N   | 115.4E | 25 | 0 | 115 |     | 0 | -5   |
| 99072712                      |   | 24.5N   | 116.4E | 20 |   |     |     |   |      |
| 99072718                      |   | 26.7N   | 118.0E | 20 |   |     |     |   |      |
|                               |   | AVERAGE |        |    | 0 | 130 | 324 | 0 | 7 15 |
|                               |   | BIAS    |        |    |   |     |     | 0 | 3 15 |
|                               |   | #       |        |    | 3 | 3   | 1   | 3 | 3 1  |
|                               |   | CASES   |        |    |   |     |     |   |      |

| Statistics for JTWC on TY 11W Olga |     |                |        |                 |    |     |     |     |     |     |             |     |    |     |     |    |
|------------------------------------|-----|----------------|--------|-----------------|----|-----|-----|-----|-----|-----|-------------|-----|----|-----|-----|----|
|                                    |     | WRN BEST TRACK |        | POSITION ERRORS |    |     |     |     |     |     | WIND ERRORS |     |    |     |     |    |
| DTG                                | NO. | LAT            | LONG   | wind            | 00 | 12  | 24  | 36  | 48  | 72  | 00          | 12  | 24 | 36  | 48  | 72 |
| 99072618                           |     | 5.5N           | 138.7E | 20              |    |     |     |     |     |     |             |     |    |     |     |    |
| 99072700                           |     | 5.9N           | 138.5E | 20              |    |     |     |     |     |     |             |     |    |     |     |    |
| 99072706                           |     | 6.7N           | 138.1E | 20              |    |     |     |     |     |     |             |     |    |     |     |    |
| 99072712                           |     | 7.3N           | 137.9E | 20              |    |     |     |     |     |     |             |     |    |     |     |    |
| 99072718                           |     | 8.2N           | 137.5E | 20              |    |     |     |     |     |     |             |     |    |     |     |    |
| 99072800                           |     | 9.3N           | 136.8E | 20              |    |     |     |     |     |     |             |     |    |     |     |    |
| 99072806                           |     | 10.0N          | 136.2E | 20              |    |     |     |     |     |     |             |     |    |     |     |    |
| 99072812                           |     | 10.9N          | 135.6E | 20              |    |     |     |     |     |     |             |     |    |     |     |    |
| 99072818                           |     | 11.7N          | 135.2E | 20              |    |     |     |     |     |     |             |     |    |     |     |    |
| 99072900                           | 1   | 12.5N          | 134.8E | 25              | 30 | 60  | 127 | 243 | 253 | 245 | 0           | 0   | -5 | 0   | -5  | 0  |
| 99072906                           | 2   | 13.5N          | 134.4E | 30              | 16 | 38  | 140 | 191 | 199 | 196 | 0           | 0   | 5  | 0   | 5   | 15 |
| 99072912                           | 3   | 14.4N          | 134.0E | 30              | 18 | 42  | 155 | 155 | 146 | 192 | 0           | -5  | 0  | -5  | 0   | 25 |
| 99072918                           | 4   | 15.5N          | 133.7E | 35              | 21 | 132 | 191 | 219 | 206 | 295 | 0           | 5   | 0  | 5   | 5   | 15 |
| 99073000                           | 5   | 16.9N          | 133.6E | 40              | 24 | 145 | 157 | 166 | 195 | 297 | 0           | 5   | 0  | 5   | 10  | 20 |
| 99073006                           | 6   | 18.9N          | 133.3E | 40              | 0  | 43  | 43  | 84  | 99  | 159 | 0           | -5  | 0  | 0   | 5   | 20 |
| 99073012                           | 7   | 20.3N          | 132.4E | 45              | 0  | 34  | 63  | 78  | 105 | 201 | 0           | -5  | 0  | 5   | 20  | 20 |
| 99073018                           | 8   | 21.0N          | 131.8E | 55              | 0  | 19  | 39  | 60  | 79  | 231 | 0           | 5   | 5  | 10  | 25  | 35 |
| 99073100                           | 9   | 21.7N          | 131.2E | 60              | 0  | 22  | 35  | 52  | 53  | 266 | 0           | 0   | 5  | 20  | 25  | 40 |
| 99073106                           | 10  | 22.7N          | 130.8E | 60              | 0  | 33  | 37  | 79  | 84  | 283 | 0           | -5  | 0  | 10  | 25  | 30 |
| 99073112                           | 11  | 23.2N          | 130.4E | 65              | 0  | 17  | 36  | 54  | 105 | 365 | 0           | 5   | 25 | 25  | 25  | 45 |
| 99073118                           | 12  | 23.7N          | 130.0E | 70              | 6  | 60  | 94  | 97  | 179 | 436 | 0           | 0   | 5  | 10  | 15  | 45 |
| 99080100                           | 13  | 24.7N          | 129.2E | 70              | 0  | 21  | 39  | 67  | 118 | 287 | 0           | 10  | 0  | -10 | -10 | 25 |
| 99080106                           | 14  | 25.5N          | 128.7E | 75              | 8  | 24  | 0   | 62  | 83  |     | 0           | 10  | 25 | 5   | -10 |    |
| 99080112                           | 15  | 26.4N          | 127.9E | 65              | 16 | 37  | 12  | 58  | 109 |     | 5           | 5   | 10 | 10  | 5   |    |
| 99080118                           | 16  | 27.2N          | 127.2E | 75              | 0  | 37  | 52  | 70  | 74  |     | 0           | 5   | 0  | -15 | 0   |    |
| 99080200                           | 17  | 27.8N          | 126.5E | 75              | 0  | 43  | 116 | 158 | 167 |     | 0           | -5  | 0  | 0   | 10  |    |
| 99080206                           | 18  | 28.7N          | 126.3E | 75              | 0  | 61  | 151 | 227 |     |     | 0           | 0   | 0  | 15  |     |    |
| 99080212                           | 19  | 30.0N          | 126.0E | 80              | 0  | 68  | 115 | 128 |     |     | 0           | -5  | -5 | 5   |     |    |
| 99080218                           | 20  | 31.6N          | 126.0E | 75              | 13 | 73  | 132 |     |     |     | 0           | -10 | 10 |     |     |    |
| 99080300                           | 21  | 33.5N          | 126.0E | 70              | 0  | 20  | 59  |     |     |     | 0           | 5   | 5  |     |     |    |
| 99080306                           | 22  | 35.7N          | 126.3E | 70              | 5  | 84  |     |     |     |     | 0           | 0   |    |     |     |    |
| 99080312                           | 23  | 37.4N          | 126.5E | 55              | 0  | 43  |     |     |     |     | 0           | 0   |    |     |     |    |
| 99080318                           | 24  | 40.0N          | 126.5E | 35              | 27 |     |     |     |     |     | 0           |     |    |     |     |    |

|                                    |         |        |    |    |     |     |     |    |    |    |    |    |    |  |
|------------------------------------|---------|--------|----|----|-----|-----|-----|----|----|----|----|----|----|--|
| Statistics for JTWC on TY 11W Olga |         |        |    |    |     |     |     |    |    |    |    |    |    |  |
| 99080400                           | 41.8N   | 126.5E | 25 |    |     |     |     |    |    |    |    |    |    |  |
|                                    | AVERAGE | 8      | 50 | 85 | 118 | 133 | 266 | 0  | 4  | 5  | 8  | 12 | 26 |  |
|                                    | BIAS    |        |    |    |     |     |     | 0  | 1  | 4  | 5  | 9  | 26 |  |
|                                    | #       | 24     | 23 | 21 | 19  | 17  | 13  | 24 | 23 | 21 | 19 | 17 | 13 |  |
|                                    | CASES   |        |    |    |     |     |     |    |    |    |    |    |    |  |

| Statistics for JTWC on TS 12W Paul |     |               |                 |      |    |     |     |     |     |     |             |     |     |     |    |    |
|------------------------------------|-----|---------------|-----------------|------|----|-----|-----|-----|-----|-----|-------------|-----|-----|-----|----|----|
|                                    | WRN | BEST<br>TRACK | POSITION ERRORS |      |    |     |     |     |     |     | WIND ERRORS |     |     |     |    |    |
| DTG                                | NO. | LAT           | LONG            | wind | 00 | 12  | 24  | 36  | 48  | 72  | 00          | 12  | 24  | 36  | 48 | 72 |
| 99073118                           |     | 11.9N         | 144.4E          | 15   |    |     |     |     |     |     |             |     |     |     |    |    |
| 99080100                           |     | 12.4N         | 143.6E          | 15   |    |     |     |     |     |     |             |     |     |     |    |    |
| 99080106                           |     | 13.0N         | 143.0E          | 15   |    |     |     |     |     |     |             |     |     |     |    |    |
| 99080112                           |     | 13.8N         | 142.5E          | 15   |    |     |     |     |     |     |             |     |     |     |    |    |
| 99080118                           |     | 14.7N         | 142.0E          | 20   |    |     |     |     |     |     |             |     |     |     |    |    |
| 99080200                           |     | 15.6N         | 141.5E          | 20   |    |     |     |     |     |     |             |     |     |     |    |    |
| 99080206                           |     | 16.4N         | 140.9E          | 20   |    |     |     |     |     |     |             |     |     |     |    |    |
| 99080212                           |     | 17.1N         | 140.2E          | 20   |    |     |     |     |     |     |             |     |     |     |    |    |
| 99080218                           |     | 18.0N         | 139.8E          | 20   |    |     |     |     |     |     |             |     |     |     |    |    |
| 99080300                           |     | 19.3N         | 139.1E          | 20   |    |     |     |     |     |     |             |     |     |     |    |    |
| 99080306                           |     | 20.4N         | 138.6E          | 20   |    |     |     |     |     |     |             |     |     |     |    |    |
| 99080312                           | 1   | 21.4N         | 138.0E          | 25   | 49 | 93  | 134 | 122 | 66  | 205 | 0           | -5  | 0   | -15 | 0  | 20 |
| 99080318                           | 2   | 22.3N         | 137.6E          | 25   | 74 | 133 | 190 | 179 | 107 | 224 | 0           | 0   | -5  | -15 | 5  | 30 |
| 99080400                           | 3   | 23.3N         | 137.1E          | 30   | 09 | 194 | 195 | 129 | 130 | 262 | 0           | 0   | -10 | 5   | 20 | 35 |
| 99080406                           | 4   | 24.4N         | 136.3E          | 30   | 0  | 8   | 77  | 234 | 389 | 348 | 0           | -5  | -15 | 5   | 25 | 20 |
| 99080412                           | 5   | 25.4N         | 135.3E          | 30   | 0  | 32  | 112 | 275 | 325 | 339 | 0           | -10 | 0   | 10  | 25 | 30 |
| 99080418                           | 6   | 26.1N         | 134.2E          | 35   | 8  | 49  | 175 | 243 | 228 | 228 | 0           | -10 | 10  | 20  | 20 | 15 |
| 99080506                           | 7   | 26.8N         | 132.6E          | 50   | 16 | 95  | 142 | 102 | 108 | 136 | 0           | 15  | 25  | 25  | 20 | 20 |
| 99080512                           | 8   | 27.0N         | 132.3E          | 35   | 12 | 108 | 205 | 293 | 429 | 606 | 0           | -5  | 0   | -5  | -5 | 0  |
| 99080518                           | 9   | 27.2N         | 132.7E          | 35   | 6  | 134 | 217 | 358 | 460 |     | 0           | 10  | 5   | -5  | -5 |    |
| 99080600                           | 10  | 28.2N         | 133.4E          | 30   | 12 | 115 | 180 | 259 | 288 |     | 0           | 5   | 5   | 5   | 0  |    |
| 99080606                           | 11  | 29.6N         | 132.8E          | 25   | 37 | 80  | 177 | 241 | 292 |     | 0           | 0   | -10 | -10 | -5 |    |
| 99080612                           | 12  | 30.7N         | 131.6E          | 25   | 35 | 120 | 193 |     |     |     | 0           | -10 | -10 |     |    |    |
| 99080618                           | 13  | 31.2N         | 130.4E          | 25   | 0  | 28  | 35  | 103 |     |     | 0           | 0   | 0   | 0   |    |    |
| 99080700                           | 14  | 32.0N         | 128.9E          | 25   | 5  | 30  | 127 | 240 |     |     | 0           | 0   | 0   | 5   |    |    |
| 99080706                           | 15  | 32.8N         | 127.0E          | 25   | 13 | 54  | 166 |     |     |     | 0           | 0   | 0   |     |    |    |
| 99080712                           | 16  | 33.4N         | 125.7E          | 25   | 0  | 54  | 104 |     |     |     | 0           | 0   | 5   |     |    |    |
| 99080718                           | 17  | 34.1N         | 124.3E          | 25   | 18 | 122 |     |     |     |     | 0           | 5   |     |     |    |    |
| 99080800                           | 18  | 34.1N         | 123.0E          | 25   | 61 | 136 |     |     |     |     | 0           | 5   |     |     |    |    |
| 99080806                           |     | 34.5N         | 121.7E          | 20   |    |     |     |     |     |     |             |     |     |     |    |    |
| 99080812                           |     | 35.0N         | 121.3E          | 15   |    |     |     |     |     |     |             |     |     |     |    |    |
|                                    |     |               | AVERAGE         |      | 25 | 88  | 152 | 214 | 256 | 294 | 0           | 5   | 6   | 10  | 12 | 21 |
|                                    |     |               | BIAS            |      |    |     |     |     |     |     | 0           | 0   | 0   | 2   | 9  | 21 |
|                                    |     |               | #               |      | 18 | 18  | 16  | 13  | 11  | 8   | 18          | 18  | 16  | 13  | 11 | 8  |
|                                    |     |               | CASES           |      |    |     |     |     |     |     |             |     |     |     |    |    |



| Statistics for JTWC on TS 13W Rachel |                |         |                 |      |    |     |     |     |     |             |    |    |     |    |     |    |
|--------------------------------------|----------------|---------|-----------------|------|----|-----|-----|-----|-----|-------------|----|----|-----|----|-----|----|
| DTG                                  | WRN BEST TRACK |         | POSITION ERRORS |      |    |     |     |     |     | WIND ERRORS |    |    |     |    |     |    |
|                                      | NO.            | LAT     | LONG            | wind | 00 | 12  | 24  | 36  | 48  | 72          | 00 | 12 | 24  | 36 | 48  | 72 |
| 99080518                             |                | 20.8N   | 116.2E          | 25   |    |     |     |     |     |             |    |    |     |    |     |    |
| 99080600                             |                | 21.3N   | 117.1E          | 30   |    |     |     |     |     |             |    |    |     |    |     |    |
| 99080606                             | 1              | 21.9N   | 117.9E          | 35   | 0  | 25  | 47  | 84  | 160 | 75          | -5 | 5  | 0   | 5  | 5   | 20 |
| 99080612                             | 2              | 22.4N   | 118.5E          | 35   | 16 | 58  | 82  | 193 | 203 | 17          | 0  | 0  | 0   | -5 | -10 | 0  |
| 99080618                             | 3              | 22.8N   | 119.0E          | 35   | 24 | 43  | 192 | 295 | 259 | 161         | 0  | 0  | -5  | -5 | 0   | 10 |
| 99080700                             | 4              | 23.2N   | 119.5E          | 35   | 36 | 182 | 294 | 320 | 262 | 239         | 0  | 10 | -5  | -5 | 5   | 15 |
| 99080706                             | 5              | 23.7N   | 120.3E          | 30   | 35 | 278 | 375 |     |     |             | 5  | -5 | -15 |    |     |    |
| 99080718                             | 6              | 25.5N   | 124.8E          | 30   | 37 | 96  | 185 | 253 | 289 | 453         | 0  | 0  | 10  | 20 | 15  | 10 |
| 99080800                             | 7              | 26.2N   | 126.6E          | 30   | 20 | 86  | 139 | 165 | 190 |             | 0  | 0  | 10  | 0  | 5   |    |
| 99080806                             | 8              | 26.9N   | 127.9E          | 35   | 0  | 28  | 62  | 76  | 127 |             | 0  | 5  | 5   | 5  | 10  |    |
| 99080812                             | 9              | 27.5N   | 128.5E          | 35   | 0  | 84  | 114 | 158 | 165 |             | 0  | 0  | 0   | 0  | 5   |    |
| 99080818                             | 10             | 28.4N   | 128.4E          | 30   | 0  | 148 | 197 | 213 | 201 |             | 0  | 0  | 5   | 10 | 10  |    |
| 99080900                             | 11             | 29.2N   | 127.8E          | 25   | 0  | 45  | 83  | 66  |     |             | 0  | 0  | 5   | 5  |     |    |
| 99080906                             | 12             | 30.0N   | 126.9E          | 25   | 0  | 43  | 53  | 54  |     |             | 0  | 5  | 5   | 10 |     |    |
| 99080912                             | 13             | 31.1N   | 125.8E          | 25   | 23 | 62  | 69  |     |     |             | 0  | 0  | 5   |    |     |    |
| 99080918                             | 14             | 32.2N   | 124.6E          | 20   | 15 | 73  | 136 |     |     |             | 0  | 0  | 0   |    |     |    |
| 99081000                             |                | 33.1N   | 123.4E          | 20   |    |     |     |     |     |             |    |    |     |    |     |    |
| 99081006                             |                | 34.1N   | 122.6E          | 15   |    |     |     |     |     |             |    |    |     |    |     |    |
| 99081012                             |                | 34.8N   | 121.7E          | 15   |    |     |     |     |     |             |    |    |     |    |     |    |
| 99081018                             |                | 35.4N   | 120.9E          | 10   |    |     |     |     |     |             |    |    |     |    |     |    |
|                                      |                | AVERAGE |                 |      | 15 | 89  | 145 | 171 | 206 | 189         | 1  | 2  | 5   | 6  | 7   | 11 |
|                                      |                | BIAS    |                 |      |    |     |     |     |     |             | 0  | 1  | 1   | 4  | 5   | 11 |
|                                      |                | # CASES |                 |      | 14 | 14  | 14  | 11  | 9   | 5           | 14 | 14 | 14  | 11 | 9   | 5  |

| Statistics for JTWC on TD 14W |                |       |                 |      |    |    |    |     |     |             |    |    |    |    |    |    |
|-------------------------------|----------------|-------|-----------------|------|----|----|----|-----|-----|-------------|----|----|----|----|----|----|
| DTG                           | WRN BEST TRACK |       | POSITION ERRORS |      |    |    |    |     |     | WIND ERRORS |    |    |    |    |    |    |
|                               | NO.            | LAT   | LONG            | wind | 00 | 12 | 24 | 36  | 48  | 72          | 00 | 12 | 24 | 36 | 48 | 72 |
| 99080700                      |                | 25.1N | 141.5E          | 25   |    |    |    |     |     |             |    |    |    |    |    |    |
| 99080706                      |                | 25.3N | 141.4E          | 25   |    |    |    |     |     |             |    |    |    |    |    |    |
| 99080712                      |                | 25.5N | 141.3E          | 25   |    |    |    |     |     |             |    |    |    |    |    |    |
| 99080718                      |                | 25.6N | 141.2E          | 25   |    |    |    |     |     |             |    |    |    |    |    |    |
| 99080800                      |                | 25.8N | 141.2E          | 25   |    |    |    |     |     |             |    |    |    |    |    |    |
| 99080806                      |                | 26.0N | 141.1E          | 20   |    |    |    |     |     |             |    |    |    |    |    |    |
| 99080812                      |                | 26.5N | 141.1E          | 25   |    |    |    |     |     |             |    |    |    |    |    |    |
| 99080818                      |                | 27.2N | 141.0E          | 25   |    |    |    |     |     |             |    |    |    |    |    |    |
| 99080900                      | 1              | 29.0N | 139.9E          | 25   | 24 | 36 | 33 | 48  | 76  |             | 0  | 5  | 15 | 15 | 15 |    |
| 99080906                      | 2              | 30.2N | 139.8E          | 25   | 10 | 16 | 31 | 53  | 122 |             | 0  | 5  | 10 | 15 | 15 |    |
| 99080912                      | 3              | 31.5N | 139.2E          | 25   | 0  | 37 | 43 | 96  |     |             | 5  | 10 | 10 | 15 |    |    |
| 99080918                      | 4              | 32.2N | 138.0E          | 25   | 0  | 28 | 68 | 115 |     |             | 0  | 0  | -5 | 0  |    |    |
| 99081000                      | 5              | 32.9N | 137.3E          | 25   | 0  | 10 | 25 |     |     |             | 0  | -5 | 0  |    |    |    |
| 99081006                      | 6              | 33.7N | 136.7E          | 25   | 6  | 12 | 37 |     |     |             | 0  | 0  | 0  |    |    |    |
| 99081012                      | 7              | 34.4N | 136.3E          | 25   | 17 | 54 |    |     |     |             | -5 | 0  |    |    |    |    |

| Statistics for JTWC on TD 14W |         |        |    |   |    |    |    |    |  |   |   |   |    |    |
|-------------------------------|---------|--------|----|---|----|----|----|----|--|---|---|---|----|----|
| 99081018                      | 35.0N   | 136.0E | 20 |   |    |    |    |    |  |   |   |   |    |    |
| 99081100                      | 35.8N   | 135.9E | 15 |   |    |    |    |    |  |   |   |   |    |    |
| 99081106                      | 36.3N   | 135.5E | 15 |   |    |    |    |    |  |   |   |   |    |    |
|                               | AVERAGE |        |    | 8 | 28 | 39 | 78 | 99 |  | 1 | 4 | 7 | 11 | 15 |
|                               | BIAS    |        |    |   |    |    |    |    |  | 0 | 2 | 5 | 11 | 15 |
|                               | #       |        |    | 7 | 7  | 6  | 4  | 2  |  | 7 | 7 | 6 | 4  | 2  |
|                               | CASES   |        |    |   |    |    |    |    |  |   |   |   |    |    |

| Statistics for JTWC on TD 15W |         |                |        |                 |    |    |     |     |     |     |             |    |    |    |    |    |
|-------------------------------|---------|----------------|--------|-----------------|----|----|-----|-----|-----|-----|-------------|----|----|----|----|----|
|                               |         | WRN BEST TRACK |        | POSITION ERRORS |    |    |     |     |     |     | WIND ERRORS |    |    |    |    |    |
| DTG                           | NO.     | LAT            | LONG   | wind            | 00 | 12 | 24  | 36  | 48  | 72  | 00          | 12 | 24 | 36 | 48 | 72 |
| 99081518                      |         | 31.0N          | 127.6E | 20              |    |    |     |     |     |     |             |    |    |    |    |    |
| 99081600                      |         | 30.8N          | 127.8E | 20              |    |    |     |     |     |     |             |    |    |    |    |    |
| 99081606                      | 1       | 30.8N          | 128.0E | 25              | 8  | 44 | 104 | 132 | 185 | 289 | 0           | 0  | 0  | 0  | -5 | -5 |
| 99081612                      | 2       | 30.9N          | 128.3E | 25              | 5  | 63 | 101 | 131 | 188 | 299 | 0           | 0  | 0  | 0  | 0  | 0  |
| 99081618                      | 3       | 31.4N          | 128.9E | 25              | 7  | 46 | 62  | 112 |     |     | 0           | 0  | -5 | -5 |    |    |
| 99081700                      | 4       | 31.7N          | 129.9E | 25              | 5  | 78 | 134 | 218 |     |     | 0           | 0  | -5 | -5 |    |    |
| 99081706                      | 5       | 32.5N          | 130.2E | 25              | 31 | 89 | 145 | 173 |     |     | 0           | 0  | -5 | 0  |    |    |
| 99081712                      | 6       | 33.2N          | 130.4E | 25              | 26 | 12 | 19  | 38  |     |     | 0           | 0  | 0  | 0  |    |    |
| 99081718                      | 7       | 33.8N          | 130.6E | 25              | 0  | 44 | 49  | 24  |     |     | 0           | 0  | 0  | -5 |    |    |
| 99081800                      | 8       | 34.5N          | 130.6E | 25              | 16 | 24 | 30  | 48  |     |     | 0           | 0  | -5 | 5  |    |    |
| 99081806                      | 9       | 35.6N          | 130.7E | 25              | 24 | 30 |     |     |     |     | 0           | 0  |    |    |    |    |
| 99081812                      |         | 36.4N          | 130.9E | 20              |    |    |     |     |     |     |             |    |    |    |    |    |
| 99081818                      |         | 37.3N          | 131.1E | 20              |    |    |     |     |     |     |             |    |    |    |    |    |
| 99081900                      |         | 38.1N          | 131.3E | 20              |    |    |     |     |     |     |             |    |    |    |    |    |
| 99081906                      |         | 38.9N          | 131.7E | 20              |    |    |     |     |     |     |             |    |    |    |    |    |
| 99081912                      |         | 40.0N          | 132.2E | 20              |    |    |     |     |     |     |             |    |    |    |    |    |
| 99081918                      |         | 41.5N          | 133.1E | 20              |    |    |     |     |     |     |             |    |    |    |    |    |
| 99082000                      |         | 42.3N          | 135.2E | 20              |    |    |     |     |     |     |             |    |    |    |    |    |
|                               | AVERAGE |                |        |                 | 14 | 48 | 80  | 110 | 187 | 294 | 0           | 0  | 3  | 3  | 3  | 3  |
|                               | BIAS    |                |        |                 |    |    |     |     |     |     | 0           | 0  | -3 | -1 | -3 | -3 |
|                               | #       |                |        |                 | 9  | 9  | 8   | 8   | 2   | 2   | 9           | 9  | 8  | 8  | 2  | 2  |
|                               | CASES   |                |        |                 |    |    |     |     |     |     |             |    |    |    |    |    |

| Statistics for JTWC on TY 16W Sam |     |                |        |                 |    |    |     |     |     |     |             |    |    |    |    |     |
|-----------------------------------|-----|----------------|--------|-----------------|----|----|-----|-----|-----|-----|-------------|----|----|----|----|-----|
|                                   |     | WRN BEST TRACK |        | POSITION ERRORS |    |    |     |     |     |     | WIND ERRORS |    |    |    |    |     |
| DTG                               | NO. | LAT            | LONG   | wind            | 00 | 12 | 24  | 36  | 48  | 72  | 00          | 12 | 24 | 36 | 48 | 72  |
| 99081718                          |     | 11.0N          | 128.3E | 15              |    |    |     |     |     |     |             |    |    |    |    |     |
| 99081800                          |     | 11.4N          | 128.9E | 20              |    |    |     |     |     |     |             |    |    |    |    |     |
| 99081806                          | 1   | 12.4N          | 128.9E | 30              | 18 | 31 | 76  | 93  | 139 | 217 | 0           | 0  | 0  | 0  | 0  | 0   |
| 99081812                          | 2   | 13.3N          | 128.3E | 30              | 0  | 78 | 75  | 116 | 147 | 237 | 0           | -5 | -5 | -5 | 0  | 0   |
| 99081818                          | 3   | 14.6N          | 127.6E | 30              | 8  | 70 | 115 | 188 | 216 | 325 | 0           | 0  | 0  | 0  | 10 | 25  |
| 99081900                          | 4   | 16.0N          | 126.8E | 35              | 32 | 78 | 147 | 199 | 231 | 426 | 0           | 5  | 5  | 10 | 15 | 10  |
| 99081906                          | 5   | 16.9N          | 125.5E | 35              | 12 | 91 | 91  | 132 | 155 | 325 | 0           | 0  | 0  | 10 | 5  | -35 |
| 99081912                          | 6   | 17.0N          | 124.7E | 40              | 0  | 63 | 97  | 99  | 131 | 275 | 0           | -5 | 0  | 0  | 5  | -15 |

| Statistics for JTWC on TY 16W Sam |    |       |        |    |    |    |     |     |     |     |    |     |     |     |     |    |
|-----------------------------------|----|-------|--------|----|----|----|-----|-----|-----|-----|----|-----|-----|-----|-----|----|
| 99081918                          | 7  | 17.2N | 123.5E | 45 | 8  | 51 | 74  | 100 | 175 | 311 | 0  | -5  | 5   | 0   | 5   | 25 |
| 99082000                          | 8  | 17.9N | 122.3E | 50 | 11 | 32 | 102 | 186 | 288 | 435 | 0  | -5  | 0   | 0   | -15 | 0  |
| 99082006                          | 9  | 18.4N | 121.1E | 55 | 8  | 90 | 123 | 157 | 233 |     | 0  | -5  | -20 | -30 | -45 |    |
| 99082012                          | 10 | 18.4N | 120.4E | 55 | 11 | 27 | 41  | 62  | 119 |     | 0  | 0   | -10 | -20 | -35 |    |
| 99082018                          | 11 | 18.6N | 119.6E | 55 | 29 | 26 | 8   | 32  | 66  |     | 0  | -5  | -10 | -30 | -10 |    |
| 99082100                          | 12 | 19.0N | 118.7E | 60 | 0  | 51 | 67  | 80  | 111 |     | 0  | 0   | -5  | -10 | 0   |    |
| 99082106                          | 13 | 19.8N | 117.7E | 65 | 8  | 46 | 66  | 111 | 125 |     | 0  | -5  | -25 | -5  | -5  |    |
| 99082112                          | 14 | 20.4N | 116.7E | 65 | 8  | 33 | 23  | 55  |     |     | -5 | -10 | -25 | -10 |     |    |
| 99082118                          | 15 | 21.1N | 115.8E | 65 | 11 | 56 | 41  | 61  |     |     | -5 | -15 | -5  | 5   |     |    |
| 99082200                          | 16 | 21.8N | 115.0E | 65 | 0  | 16 | 6   |     |     |     | 0  | -10 | -5  |     |     |    |
| 99082206                          | 17 | 22.1N | 114.6E | 75 | 0  | 25 | 12  |     |     |     | 0  | 10  | 5   |     |     |    |
| 99082212                          | 18 | 22.7N | 113.9E | 65 | 5  | 29 |     |     |     |     | 0  | 5   |     |     |     |    |
| 99082218                          | 19 | 23.2N | 113.2E | 40 | 0  | 25 |     |     |     |     | 0  | 0   |     |     |     |    |
| 99082300                          | 20 | 23.5N | 112.9E | 35 | 12 |    |     |     |     |     | 0  |     |     |     |     |    |
| 99082306                          |    | 24.0N | 112.6E | 25 |    |    |     |     |     |     |    |     |     |     |     |    |
| AVERAGE                           |    |       |        |    | 9  | 48 | 68  | 111 | 164 | 319 | 1  | 5   | 7   | 9   | 12  | 14 |
| BIAS                              |    |       |        |    |    |    |     |     |     |     | -1 | -3  | -6  | -6  | -5  | 1  |
| # CASES                           |    |       |        |    | 20 | 19 | 17  | 15  | 13  | 8   | 20 | 19  | 17  | 15  | 13  | 8  |

| Statistics for JTWC on TY 17W Tanya |     |                |        |                 |    |    |     |     |     |     |             |     |     |     |     |     |
|-------------------------------------|-----|----------------|--------|-----------------|----|----|-----|-----|-----|-----|-------------|-----|-----|-----|-----|-----|
|                                     |     | WRN BEST TRACK |        | POSITION ERRORS |    |    |     |     |     |     | WIND ERRORS |     |     |     |     |     |
| DTG                                 | NO. | LAT            | LONG   | wind            | 00 | 12 | 24  | 36  | 48  | 72  | 00          | 12  | 24  | 36  | 48  | 72  |
| 99081900                            |     | 29.5N          | 179.5W | 20              |    |    |     |     |     |     |             |     |     |     |     |     |
| 99081906                            |     | 29.5N          | 180.0W | 20              |    |    |     |     |     |     |             |     |     |     |     |     |
| 99081912                            |     | 29.6N          | 179.3E | 25              |    |    |     |     |     |     |             |     |     |     |     |     |
| 99081918                            | 1   | 29.8N          | 177.9E | 30              | 18 | 71 | 98  | 139 | 192 | 243 | 0           | -20 | -40 | -50 | -40 | -35 |
| 99082000                            | 2   | 29.9N          | 176.3E | 35              | 5  | 17 | 21  | 70  | 86  | 46  | 0           | -5  | -20 | -25 | -35 | -20 |
| 99082006                            | 3   | 30.1N          | 174.7E | 45              | 16 | 40 | 67  | 97  | 137 | 194 | 0           | -5  | -20 | -25 | -35 | -10 |
| 99082012                            | 4   | 30.4N          | 173.1E | 50              | 6  | 16 | 30  | 47  | 40  | 96  | 0           | -15 | -20 | -30 | -30 | -5  |
| 99082018                            | 5   | 30.9N          | 171.5E | 55              | 11 | 31 | 39  | 36  | 32  | 262 | 0           | -10 | -15 | -25 | -20 | 5   |
| 99082100                            | 6   | 31.2N          | 169.9E | 65              | 0  | 24 | 48  | 43  | 51  | 308 | 0           | -5  | -20 | -25 | -15 | 5   |
| 99082106                            | 7   | 31.5N          | 168.2E | 65              | 0  | 19 | 41  | 70  | 119 | 477 | 0           | -5  | -20 | -20 | -5  | 5   |
| 99082112                            | 8   | 31.8N          | 166.8E | 65              | 0  | 41 | 77  | 131 | 194 | 502 | 0           | -10 | -15 | -10 | 0   | 5   |
| 99082118                            | 9   | 32.1N          | 165.2E | 65              | 0  | 6  | 12  | 53  | 131 |     | 0           | -5  | -15 | 0   | 5   |     |
| 99082200                            | 10  | 32.5N          | 163.8E | 70              | 0  | 12 | 16  | 62  | 97  |     | 0           | 5   | 15  | 20  | 15  |     |
| 99082206                            | 11  | 33.1N          | 162.3E | 70              | 0  | 12 | 27  | 89  | 157 |     | 0           | 10  | 25  | 25  | 15  |     |
| 99082212                            | 12  | 33.8N          | 161.1E | 65              | 6  | 20 | 71  | 130 | 284 |     | 0           | 15  | 25  | 25  | 15  |     |
| 99082218                            | 13  | 34.6N          | 159.6E | 60              | 0  | 19 | 76  | 150 |     |     | 0           | 20  | 25  | 20  |     |     |
| 99082300                            | 14  | 35.5N          | 158.5E | 50              | 0  | 69 | 154 | 219 |     |     | 5           | 20  | 20  | 15  |     |     |
| 99082306                            | 15  | 36.5N          | 157.8E | 40              | 0  | 63 | 106 |     |     |     | 10          | 10  | 5   |     |     |     |
| 99082312                            | 16  | 37.7N          | 157.8E | 35              | 0  | 28 | 119 |     |     |     | 0           | 5   | 0   |     |     |     |
| 99082318                            | 17  | 39.0N          | 158.5E | 30              | 11 | 73 |     |     |     |     | 0           | 0   |     |     |     |     |
| 99082400                            | 18  | 39.9N          | 159.5E | 25              | 11 | 42 |     |     |     |     | 0           | 0   |     |     |     |     |
| 99082406                            |     | 40.5N          | 161.5E | 25              |    |    |     |     |     |     |             |     |     |     |     |     |
| 99082412                            |     | 41.2N          | 164.3E | 25              |    |    |     |     |     |     |             |     |     |     |     |     |

|                                     |         |    |    |    |    |     |     |    |    |    |    |     |    |
|-------------------------------------|---------|----|----|----|----|-----|-----|----|----|----|----|-----|----|
| Statistics for JTWC on TY 17W Tanya |         |    |    |    |    |     |     |    |    |    |    |     |    |
|                                     | AVERAGE | 5  | 33 | 63 | 95 | 127 | 266 | 1  | 9  | 19 | 23 | 19  | 11 |
|                                     | BIAS    |    |    |    |    |     |     | 1  | 0  | -4 | -8 | -11 | -6 |
|                                     | # CASES | 18 | 18 | 16 | 14 | 12  | 8   | 18 | 18 | 16 | 14 | 12  | 8  |

| Statistics for JTWC on TD 18W |     |            |        |      |                 |     |     |     |    |    |    |             |     |    |    |    |  |
|-------------------------------|-----|------------|--------|------|-----------------|-----|-----|-----|----|----|----|-------------|-----|----|----|----|--|
|                               | WRN | BEST TRACK |        |      | POSITION ERRORS |     |     |     |    |    |    | WIND ERRORS |     |    |    |    |  |
| DTG                           | NO. | LAT        | LONG   | wind | 00              | 12  | 24  | 36  | 48 | 72 | 00 | 12          | 24  | 36 | 48 | 72 |  |
| 99082018                      |     | 32.1N      | 151.9E | 20   |                 |     |     |     |    |    |    |             |     |    |    |    |  |
| 99082100                      |     | 32.3N      | 151.0E | 20   |                 |     |     |     |    |    |    |             |     |    |    |    |  |
| 99082106                      |     | 32.5N      | 150.2E | 20   |                 |     |     |     |    |    |    |             |     |    |    |    |  |
| 99082112                      |     | 32.9N      | 149.4E | 20   |                 |     |     |     |    |    |    |             |     |    |    |    |  |
| 99082118                      | 1   | 33.2N      | 148.7E | 25   | 6               | 19  | 26  | 11  |    |    | 0  | -5          | -5  | -5 |    |    |  |
| 99082200                      | 2   | 33.7N      | 147.9E | 25   | 11              | 68  | 133 |     |    |    | 0  | 0           | -5  |    |    |    |  |
| 99082206                      | 3   | 34.2N      | 147.1E | 30   | 42              | 84  | 101 | 107 |    |    | 0  | 0           | 0   | -5 |    |    |  |
| 99082212                      | 4   | 34.6N      | 146.4E | 25   | 45              | 103 | 130 |     |    |    | 0  | -5          | -10 |    |    |    |  |
| 99082218                      | 5   | 35.0N      | 145.9E | 25   | 43              | 68  | 105 |     |    |    | 0  | -5          | -10 |    |    |    |  |
| 99082300                      | 6   | 35.3N      | 145.7E | 25   | 0               | 34  | 78  |     |    |    | 0  | -5          | -10 |    |    |    |  |
| 99082306                      | 7   | 35.8N      | 145.6E | 25   | 7               | 38  | 61  |     |    |    | 0  | 0           | 0   |    |    |    |  |
| 99082312                      | 8   | 36.1N      | 145.6E | 25   | 30              | 107 | 169 |     |    |    | 0  | 0           | 5   |    |    |    |  |
| 99082318                      | 9   | 36.4N      | 145.8E | 25   | 11              | 43  | 13  |     |    |    | 0  | 5           | 5   |    |    |    |  |
| 99082400                      | 10  | 36.7N      | 146.2E | 25   | 0               | 45  |     |     |    |    | 0  | 10          |     |    |    |    |  |
| 99082406                      |     | 37.2N      | 146.9E | 20   |                 |     |     |     |    |    |    |             |     |    |    |    |  |
| 99082412                      |     | 38.1N      | 147.7E | 15   |                 |     |     |     |    |    |    |             |     |    |    |    |  |
| 99082418                      |     | 39.7N      | 148.8E | 15   |                 |     |     |     |    |    |    |             |     |    |    |    |  |
|                               |     | AVERAGE    |        |      | 20              | 61  | 91  | 59  |    |    | 0  | 4           | 6   | 5  |    |    |  |
|                               |     | BIAS       |        |      |                 |     |     |     |    |    | 0  | -1          | -3  | -5 |    |    |  |
|                               |     | # CASES    |        |      | 10              | 10  | 9   | 2   |    |    | 10 | 10          | 9   | 2  |    |    |  |

| Statistics for JTWC on TY 19W Virgil |     |               |                 |      |    |    |     |     |     |     |             |     |     |     |     |     |
|--------------------------------------|-----|---------------|-----------------|------|----|----|-----|-----|-----|-----|-------------|-----|-----|-----|-----|-----|
|                                      | WRN | BEST<br>TRACK | POSITION ERRORS |      |    |    |     |     |     |     | WIND ERRORS |     |     |     |     |     |
| DTG                                  | NO. | LAT           | LONG            | wind | 00 | 12 | 24  | 36  | 48  | 72  | 00          | 12  | 24  | 36  | 48  | 72  |
| 99082300                             |     | 27.2N         | 139.9E          | 20   |    |    |     |     |     |     |             |     |     |     |     |     |
| 99082306                             |     | 26.9N         | 139.7E          | 20   |    |    |     |     |     |     |             |     |     |     |     |     |
| 99082312                             |     | 26.6N         | 139.6E          | 20   |    |    |     |     |     |     |             |     |     |     |     |     |
| 99082318                             |     | 26.2N         | 139.5E          | 20   |    |    |     |     |     |     |             |     |     |     |     |     |
| 99082400                             | 1   | 25.6N         | 140.0E          | 25   | 10 | 16 | 72  | 153 | 226 | 281 | 0           | 5   | 0   | -35 | -30 | -15 |
| 99082406                             | 2   | 25.4N         | 140.3E          | 25   | 10 | 24 | 109 | 149 | 184 | 180 | 0           | -5  | -35 | -40 | -35 | -10 |
| 99082412                             | 3   | 25.3N         | 140.7E          | 25   | 26 | 55 | 134 | 195 | 223 | 235 | 0           | 0   | -40 | -30 | -25 | 5   |
| 99082418                             | 4   | 25.4N         | 141.2E          | 30   | 16 | 96 | 143 | 196 | 203 | 241 | 0           | -35 | -40 | -30 | -15 | 5   |
| 99082500                             | 5   | 25.7N         | 141.8E          | 30   | 10 | 76 | 125 | 163 | 224 | 406 | 0           | -35 | -30 | -25 | -10 | 10  |
| 99082506                             | 6   | 26.1N         | 142.9E          | 65   | 13 | 60 | 84  | 139 | 208 | 360 | 0           | 0   | 10  | 30  | 20  | 25  |
| 99082512                             | 7   | 26.3N         | 143.5E          | 70   | 0  | 16 | 32  | 112 | 196 | 343 | 0           | 10  | 25  | 35  | 30  | 25  |
| 99082518                             | 8   | 26.6N         | 144.2E          | 70   | 0  | 12 | 76  | 153 | 270 | 450 | 5           | 15  | 20  | 20  | 30  | 25  |

| Statistics for JTWC on TY 19W Virgil |    |         |        |    |    |    |     |     |     |     |    |    |    |    |    |    |
|--------------------------------------|----|---------|--------|----|----|----|-----|-----|-----|-----|----|----|----|----|----|----|
| 99082600                             | 9  | 27.1N   | 144.9E | 65 | 6  | 32 | 71  | 128 | 202 | 427 | 0  | 5  | 5  | 10 | 5  | 0  |
| 99082606                             | 10 | 27.5N   | 145.3E | 65 | 16 | 99 | 195 | 293 | 393 |     | 0  | 5  | 0  | 5  | 0  |    |
| 99082612                             | 11 | 27.9N   | 145.6E | 60 | 5  | 34 | 77  | 147 | 222 | 477 | 0  | 0  | 10 | 5  | 5  | 0  |
| 99082618                             | 12 | 28.1N   | 145.7E | 50 | 0  | 21 | 50  | 130 | 206 |     | 0  | 0  | 5  | 0  | 0  |    |
| 99082700                             | 13 | 28.4N   | 145.9E | 50 | 12 | 37 | 78  | 182 | 290 |     | 0  | 10 | 5  | 5  | 0  |    |
| 99082706                             | 14 | 28.6N   | 146.1E | 45 | 5  | 20 | 87  | 179 | 321 |     | 0  | 5  | 0  | 0  | -5 |    |
| 99082712                             | 15 | 28.9N   | 146.4E | 35 | 0  | 30 | 78  | 144 |     |     | 0  | 0  | 0  | -5 |    |    |
| 99082718                             | 16 | 29.2N   | 146.7E | 30 | 5  | 55 | 135 | 246 |     |     | 0  | -5 | 0  | -5 |    |    |
| 99082800                             | 17 | 29.4N   | 147.2E | 30 | 8  | 83 | 180 | 331 |     |     | 0  | 0  | 0  | -5 |    |    |
| 99082806                             | 18 | 29.7N   | 148.3E | 30 | 8  | 45 | 160 | 279 |     |     | 0  | 0  | 0  | 0  |    |    |
| 99082812                             | 19 | 30.2N   | 149.5E | 25 | 15 | 72 | 175 |     |     |     | 0  | 0  | -5 |    |    |    |
| 99082818                             | 20 | 30.6N   | 150.8E | 25 | 5  | 63 | 153 |     |     |     | 0  | 0  | 0  |    |    |    |
| 99082900                             | 21 | 30.9N   | 152.2E | 25 | 5  | 91 |     |     |     |     | 0  | -5 |    |    |    |    |
| 99082906                             |    | 30.9N   | 154.2E | 25 |    |    |     |     |     |     |    |    |    |    |    |    |
| 99082912                             |    | 30.7N   | 156.0E | 25 |    |    |     |     |     |     |    |    |    |    |    |    |
| 99082918                             |    | 30.7N   | 157.9E | 20 |    |    |     |     |     |     |    |    |    |    |    |    |
|                                      |    | AVERAGE |        |    | 9  | 49 | 111 | 184 | 241 | 340 | 0  | 7  | 12 | 16 | 15 | 12 |
|                                      |    | BIAS    |        |    |    |    |     |     |     |     | 0  | -1 | -4 | -4 | -2 | 7  |
|                                      |    | #       |        |    | 21 | 21 | 20  | 18  | 14  | 10  | 21 | 21 | 20 | 18 | 14 | 10 |
|                                      |    | CASES   |        |    |    |    |     |     |     |     |    |    |    |    |    |    |

| Statistics for JTWC on TS 20W Wendy |     |       |               |                 |    |     |     |     |     |     |             |     |     |     |     |    |
|-------------------------------------|-----|-------|---------------|-----------------|----|-----|-----|-----|-----|-----|-------------|-----|-----|-----|-----|----|
|                                     |     | WRN   | BEST<br>TRACK | POSITION ERRORS |    |     |     |     |     |     | WIND ERRORS |     |     |     |     |    |
| DTG                                 | NO. | LAT   | LONG          | wind            | 00 | 12  | 24  | 36  | 48  | 72  | 00          | 12  | 24  | 36  | 48  | 72 |
| 99082906                            |     | 11.5N | 133.4E        | 15              |    |     |     |     |     |     |             |     |     |     |     |    |
| 99082912                            |     | 11.5N | 132.8E        | 15              |    |     |     |     |     |     |             |     |     |     |     |    |
| 99082918                            |     | 11.5N | 132.2E        | 15              |    |     |     |     |     |     |             |     |     |     |     |    |
| 99083000                            |     | 11.5N | 131.5E        | 20              |    |     |     |     |     |     |             |     |     |     |     |    |
| 99083006                            |     | 11.5N | 130.9E        | 20              |    |     |     |     |     |     |             |     |     |     |     |    |
| 99083012                            |     | 11.6N | 130.2E        | 20              |    |     |     |     |     |     |             |     |     |     |     |    |
| 99083018                            |     | 11.8N | 129.6E        | 20              |    |     |     |     |     |     |             |     |     |     |     |    |
| 99083100                            |     | 12.0N | 129.2E        | 20              |    |     |     |     |     |     |             |     |     |     |     |    |
| 99083106                            |     | 12.2N | 128.7E        | 20              |    |     |     |     |     |     |             |     |     |     |     |    |
| 99083112                            |     | 12.3N | 128.2E        | 20              |    |     |     |     |     |     |             |     |     |     |     |    |
| 99083118                            |     | 12.5N | 127.5E        | 20              |    |     |     |     |     |     |             |     |     |     |     |    |
| 99090100                            | 1   | 12.7N | 127.0E        | 25              | 5  | 37  | 152 | 232 | 303 | 405 | 0           | 0   | 5   | 0   | -15 | 0  |
| 99090106                            | 2   | 13.0N | 126.7E        | 25              | 6  | 107 | 279 | 344 | 398 | 519 | 0           | 0   | 5   | -5  | -10 | 10 |
| 99090112                            | 3   | 13.6N | 126.2E        | 25              | 32 | 224 | 334 | 406 | 444 |     | 0           | 0   | 0   | -10 | -10 |    |
| 99090118                            | 4   | 14.9N | 124.9E        | 25              | 87 | 251 | 325 | 370 | 413 |     | 0           | 0   | -10 | -10 | -10 |    |
| 99090200                            | 5   | 16.8N | 123.8E        | 25              | 25 | 96  | 174 | 210 | 245 |     | 0           | 0   | -5  | -5  | 10  |    |
| 99090206                            | 6   | 18.2N | 122.5E        | 25              | 8  | 23  | 61  | 101 | 173 |     | 0           | -5  | -5  | 5   | 15  |    |
| 99090212                            | 7   | 19.0N | 121.7E        | 30              | 18 | 73  | 45  | 56  |     |     | 0           | -10 | 0   | 15  |     |    |
| 99090218                            | 8   | 19.8N | 120.3E        | 35              | 5  | 6   | 16  | 68  |     |     | 0           | 0   | 5   | 5   |     |    |
| 99090300                            | 9   | 20.6N | 119.2E        | 40              | 16 | 57  | 83  |     |     |     | 0           | 5   | 15  |     |     |    |
| 99090306                            | 10  | 21.3N | 118.3E        | 40              | 37 | 37  | 45  |     |     |     | 0           | -5  | 5   |     |     |    |
| 99090312                            | 11  | 22.1N | 117.5E        | 40              | 12 | 13  |     |     |     |     | 0           | -5  |     |     |     |    |

| Statistics for JTWC on TS 20W Wendy |    |       |           |    |    |     |     |     |     |    |    |    |    |    |   |
|-------------------------------------|----|-------|-----------|----|----|-----|-----|-----|-----|----|----|----|----|----|---|
| 99090318                            | 12 | 22.8N | 116.5E 40 | 5  | 47 |     |     |     |     | 0  | 10 |    |    |    |   |
| 99090400                            | 13 | 23.4N | 115.5E 30 | 0  |    |     |     |     |     | 0  |    |    |    |    |   |
| 99090406                            |    | 24.6N | 114.5E 20 |    |    |     |     |     |     |    |    |    |    |    |   |
|                                     |    |       | AVERAGE   | 20 | 81 | 151 | 224 | 329 | 462 | 0  | 3  | 6  | 7  | 12 | 5 |
|                                     |    |       | BIAS      |    |    |     |     |     |     | 0  | -1 | 2  | -1 | -3 | 5 |
|                                     |    |       | # CASES   | 13 | 12 | 10  | 8   | 6   | 2   | 13 | 12 | 10 | 8  | 6  | 2 |

| Statistics for JTWC on TY 21W York |     |                |         |                 |    |     |     |     |     |     |             |     |     |     |     |     |
|------------------------------------|-----|----------------|---------|-----------------|----|-----|-----|-----|-----|-----|-------------|-----|-----|-----|-----|-----|
|                                    |     | WRN BEST TRACK |         | POSITION ERRORS |    |     |     |     |     |     | WIND ERRORS |     |     |     |     |     |
| DTG                                | NO. | LAT            | LONG    | wind            | 00 | 12  | 24  | 36  | 48  | 72  | 00          | 12  | 24  | 36  | 48  | 72  |
| 99091000                           |     | 16.5N          | 124.4E  | 25              |    |     |     |     |     |     |             |     |     |     |     |     |
| 99091006                           |     | 16.4N          | 124.1E  | 25              |    |     |     |     |     |     |             |     |     |     |     |     |
| 99091012                           |     | 16.1N          | 123.5E  | 25              |    |     |     |     |     |     |             |     |     |     |     |     |
| 99091018                           |     | 16.1N          | 122.9E  | 20              |    |     |     |     |     |     |             |     |     |     |     |     |
| 99091100                           |     | 16.0N          | 122.2E  | 20              |    |     |     |     |     |     |             |     |     |     |     |     |
| 99091106                           |     | 15.5N          | 122.7E  | 20              |    |     |     |     |     |     |             |     |     |     |     |     |
| 99091112                           |     | 16.0N          | 123.3E  | 20              |    |     |     |     |     |     |             |     |     |     |     |     |
| 99091118                           | 1   | 18.5N          | 119.0E  | 25 3            | 02 | 334 | 333 | 301 | 256 | 135 | 0           | 5   | 0   | 0   | 0   | -10 |
| 99091200                           | 2   | 18.5N          | 118.7E  | 25 3            | 26 | 324 | 311 | 250 | 170 | 127 | 0           | 5   | 0   | -5  | -5  | -10 |
| 99091206                           | 3   | 18.5N          | 118.4E  | 25 1            | 08 | 103 | 83  | 68  | 62  | 87  | 0           | 0   | 0   | 0   | 0   | -5  |
| 99091212                           | 4   | 18.5N          | 118.1E  | 25              | 39 | 80  | 124 | 153 | 166 | 229 | 5           | 5   | 0   | 0   | 0   | -20 |
| 99091218                           | 5   | 18.6N          | 117.8E  | 30              | 34 | 106 | 179 | 220 | 263 | 301 | 0           | 0   | 0   | 0   | -5  | -40 |
| 99091300                           | 6   | 18.7N          | 117.6E  | 30              | 49 | 102 | 138 | 154 | 191 | 211 | 0           | -5  | -10 | -10 | -10 | -45 |
| 99091306                           | 7   | 18.8N          | 117.4E  | 35              | 5  | 46  | 80  | 116 | 159 | 184 | 0           | 0   | 0   | -10 | -10 | -35 |
| 99091312                           | 8   | 19.0N          | 117.2E  | 40              | 13 | 30  | 68  | 93  | 115 | 126 | 0           | 0   | 5   | 10  | 10  | 0   |
| 99091318                           | 9   | 19.2N          | 117.0E  | 40              | 36 | 66  | 90  | 92  | 93  | 90  | 0           | 0   | -5  | 0   | -5  | 20  |
| 99091400                           | 10  | 19.5N          | 116.7E  | 45              | 41 | 61  | 102 | 152 | 167 | 186 | 0           | -5  | -5  | -5  | -15 | 0   |
| 99091406                           | 11  | 19.9N          | 116.4E  | 45              | 0  | 13  | 34  | 56  | 39  | 68  | 0           | -10 | -10 | -15 | -15 | 5   |
| 99091412                           | 12  | 20.4N          | 116.1E  | 50              | 0  | 23  | 52  | 51  | 38  | 71  | 0           | 0   | -5  | -15 | -15 | 5   |
| 99091418                           | 13  | 20.8N          | 115.9E  | 55              | 0  | 16  | 33  | 77  | 73  |     | 0           | 0   | -5  | -15 | -15 |     |
| 99091500                           | 14  | 21.1N          | 115.7E  | 55              | 5  | 29  | 62  | 103 | 96  |     | 0           | -5  | -5  | 0   | -5  |     |
| 99091506                           | 15  | 21.3N          | 115.5E  | 60              | 0  | 0   | 33  | 35  | 8   |     | 0           | 0   | -10 | 5   | 5   |     |
| 99091512                           | 16  | 21.7N          | 115.2E  | 65              | 13 | 23  | 50  | 60  | 29  |     | 0           | 5   | 5   | 15  | 10  |     |
| 99091518                           | 17  | 21.9N          | 114.9E  | 70              | 8  | 39  | 55  | 66  |     |     | 0           | 5   | 20  | 20  |     |     |
| 99091600                           | 18  | 22.1N          | 114.3E  | 70              | 20 | 37  | 55  |     |     |     | 0           | -10 | -5  |     |     |     |
| 99091606                           | 19  | 22.2N          | 113.7E  | 70              | 5  | 24  | 51  |     |     |     | 0           | 5   | 5   |     |     |     |
| 99091612                           | 20  | 22.5N          | 113.1E  | 55              | 0  | 53  | 80  |     |     |     | 0           | 5   | 5   |     |     |     |
| 99091618                           | 21  | 23.0N          | 112.5E  | 40              | 13 | 49  |     |     |     |     | 0           | 0   |     |     |     |     |
| 99091700                           | 22  | 23.5N          | 112.1E  | 30              | 0  | 62  |     |     |     |     | 0           | 0   |     |     |     |     |
| 99091706                           |     | 23.8N          | 111.9E  | 25              |    |     |     |     |     |     |             |     |     |     |     |     |
| 99091712                           |     | 24.1N          | 111.7E  | 20              |    |     |     |     |     |     |             |     |     |     |     |     |
|                                    |     |                | AVERAGE |                 | 47 | 74  | 101 | 120 | 120 | 151 | 0           | 3   | 5   | 7   | 8   | 16  |
|                                    |     |                | BIAS    |                 |    |     |     |     |     |     | 0           | 0   | -1  | -1  | -5  | -11 |
|                                    |     |                | # CASES |                 | 22 | 22  | 20  | 17  | 16  | 12  | 22          | 22  | 20  | 17  | 16  | 12  |

| Statistics for JTWC on TS 22W Zia |     |       |        |                 |    |     |     |     |    |    |             |     |    |    |    |    |
|-----------------------------------|-----|-------|--------|-----------------|----|-----|-----|-----|----|----|-------------|-----|----|----|----|----|
|                                   |     | WRN   | BEST   | POSITION ERRORS |    |     |     |     |    |    | WIND ERRORS |     |    |    |    |    |
| DTG                               | NO. | LAT   | LONG   | wind            | 00 | 12  | 24  | 36  | 48 | 72 | 00          | 12  | 24 | 36 | 48 | 72 |
| 99091100                          |     | 17.5N | 141.4E | 15              |    |     |     |     |    |    |             |     |    |    |    |    |
| 99091106                          |     | 18.4N | 140.4E | 15              |    |     |     |     |    |    |             |     |    |    |    |    |
| 99091112                          |     | 19.8N | 139.5E | 15              |    |     |     |     |    |    |             |     |    |    |    |    |
| 99091118                          |     | 21.0N | 139.0E | 15              |    |     |     |     |    |    |             |     |    |    |    |    |
| 99091200                          |     | 22.0N | 138.6E | 15              |    |     |     |     |    |    |             |     |    |    |    |    |
| 99091206                          |     | 23.0N | 138.0E | 20              |    |     |     |     |    |    |             |     |    |    |    |    |
| 99091212                          |     | 24.3N | 137.3E | 20              |    |     |     |     |    |    |             |     |    |    |    |    |
| 99091218                          |     | 25.4N | 136.4E | 20              |    |     |     |     |    |    |             |     |    |    |    |    |
| 99091300                          |     | 26.4N | 135.4E | 20              |    |     |     |     |    |    |             |     |    |    |    |    |
| 99091306                          |     | 27.3N | 134.2E | 20              |    |     |     |     |    |    |             |     |    |    |    |    |
| 99091312                          |     | 28.3N | 133.0E | 20              |    |     |     |     |    |    |             |     |    |    |    |    |
| 99091318                          | 1   | 29.1N | 132.4E | 35              | 0  | 24  | 148 | 354 |    |    | 0           | -10 | 0  | 5  |    |    |
| 99091400                          | 2   | 30.2N | 131.5E | 40              | 15 | 57  | 219 | 451 |    |    | -5          | 0   | 0  | 5  |    |    |
| 99091406                          | 3   | 31.1N | 131.1E | 45              | 0  | 81  | 209 |     |    |    | -10         | -5  | -5 |    |    |    |
| 99091412                          | 4   | 32.1N | 131.4E | 35              | 5  | 101 | 245 |     |    |    | 0           | -5  | 0  |    |    |    |
| 99091418                          | 5   | 33.7N | 132.8E | 35              | 38 | 120 |     |     |    |    | 0           | 0   |    |    |    |    |
| 99091500                          | 6   | 34.9N | 134.4E | 35              | 0  | 34  |     |     |    |    | 0           | 5   |    |    |    |    |
| 99091506                          | 7   | 35.8N | 137.0E | 30              | 5  |     |     |     |    |    | 0           |     |    |    |    |    |
| 99091512                          |     | 37.0N | 140.0E | 25              |    |     |     |     |    |    |             |     |    |    |    |    |
| AVERAGE                           |     |       |        |                 | 9  | 69  | 205 | 403 |    |    | 2           | 4   | 1  | 5  |    |    |
| BIAS                              |     |       |        |                 |    |     |     |     |    |    | -2          | -3  | -1 | 5  |    |    |
| # CASES                           |     |       |        |                 | 7  | 6   | 4   | 2   |    |    | 7           | 6   | 4  | 2  |    |    |

| Statistics for JTWC on TS 23W Ann |     |       |        |                 |    |    |     |     |     |     |             |     |     |     |     |     |
|-----------------------------------|-----|-------|--------|-----------------|----|----|-----|-----|-----|-----|-------------|-----|-----|-----|-----|-----|
|                                   |     | WRN   | BEST   | POSITION ERRORS |    |    |     |     |     |     | WIND ERRORS |     |     |     |     |     |
| DTG                               | NO. | LAT   | LONG   | wind            | 00 | 12 | 24  | 36  | 48  | 72  | 00          | 12  | 24  | 36  | 48  | 72  |
| 99091500                          |     | 26.5N | 129.4E | 15              |    |    |     |     |     |     |             |     |     |     |     |     |
| 99091506                          |     | 26.8N | 129.4E | 20              |    |    |     |     |     |     |             |     |     |     |     |     |
| 99091512                          |     | 27.4N | 129.3E | 20              |    |    |     |     |     |     |             |     |     |     |     |     |
| 99091518                          | 1   | 28.8N | 129.0E | 30              | 5  | 69 | 99  | 73  | 55  | 90  | 0           | -5  | -10 | -15 | -20 | -25 |
| 99091600                          | 2   | 29.5N | 128.1E | 30              | 12 | 75 | 131 | 195 | 255 | 310 | 0           | 0   | -5  | -15 | -25 | -20 |
| 99091606                          | 3   | 29.6N | 127.3E | 40              | 20 | 91 | 181 | 259 | 329 | 289 | 0           | 10  | 20  | 20  | 10  | 10  |
| 99091612                          | 4   | 29.5N | 127.0E | 40              | 27 | 59 | 114 | 173 | 222 | 273 | 0           | 5   | 5   | 5   | -5  | -5  |
| 99091618                          | 5   | 29.6N | 126.5E | 40              | 21 | 37 | 48  | 59  | 115 | 230 | -5          | -10 | -15 | -20 | -20 | -5  |
| 99091700                          | 6   | 29.6N | 126.1E | 40              | 31 | 42 | 34  | 78  | 121 | 367 | -5          | -15 | -15 | -20 | -20 | -10 |
| 99091706                          | 7   | 29.7N | 125.7E | 40              | 19 | 26 | 34  | 73  | 155 | 352 | 0           | -5  | -10 | -15 | -10 | 0   |
| 99091712                          | 8   | 29.8N | 125.3E | 45              | 24 | 29 | 50  | 97  | 177 |     | 0           | 0   | -5  | -5  | -10 |     |
| 99091718                          | 9   | 30.0N | 124.7E | 45              | 19 | 50 | 122 | 192 | 247 |     | 0           | 0   | -5  | 0   | 0   |     |
| 99091800                          | 10  | 30.3N | 124.3E | 45              | 0  | 41 | 96  | 145 | 201 |     | 0           | 0   | 0   | 0   | 5   |     |
| 99091806                          | 11  | 30.7N | 124.0E | 45              | 0  | 56 | 74  | 106 | 183 |     | 0           | 0   | 10  | 10  | 5   |     |
| 99091812                          | 12  | 31.3N | 123.2E | 45              | 11 | 28 | 55  | 147 |     |     | 0           | 5   | 5   | 5   |     |     |
| 99091818                          | 13  | 31.9N | 122.3E | 45              | 20 | 84 | 145 | 217 |     |     | 0           | 10  | 15  | 10  |     |     |

| Statistics for JTWC on TS 23W Ann |    |         |        |    |    |     |     |     |     |     |    |    |    |    |    |    |
|-----------------------------------|----|---------|--------|----|----|-----|-----|-----|-----|-----|----|----|----|----|----|----|
| 99091900                          | 14 | 32.6N   | 121.9E | 40 | 0  | 70  | 166 |     |     | 0   | 0  | 0  |    |    |    |    |
| 99091906                          | 15 | 33.8N   | 122.3E | 35 | 17 | 62  | 147 |     |     | 0   | 5  | 5  |    |    |    |    |
| 99091912                          | 16 | 34.2N   | 123.2E | 35 | 13 | 106 |     |     |     | 0   | 5  |    |    |    |    |    |
| 99092000                          | 17 | 34.6N   | 125.6E | 25 | 11 |     |     |     |     | 0   |    |    |    |    |    |    |
| 99092006                          |    | 34.7N   | 126.4E | 20 |    |     |     |     |     |     |    |    |    |    |    |    |
|                                   |    | AVERAGE |        |    | 15 | 58  | 100 | 140 | 187 | 273 | 1  | 5  | 8  | 11 | 12 | 11 |
|                                   |    | BIAS    |        |    |    |     |     |     |     |     | -1 | 0  | 0  | -3 | -8 | -8 |
|                                   |    | #       |        |    | 17 | 16  | 15  | 13  | 11  | 7   | 17 | 16 | 15 | 13 | 11 | 7  |
|                                   |    | CASES   |        |    |    |     |     |     |     |     |    |    |    |    |    |    |

| Statistics for JTWC on STY24W Bart |     |                |        |                 |    |     |     |     |     |     |             |     |     |     |     |     |
|------------------------------------|-----|----------------|--------|-----------------|----|-----|-----|-----|-----|-----|-------------|-----|-----|-----|-----|-----|
|                                    |     | WRN BEST TRACK |        | POSITION ERRORS |    |     |     |     |     |     | WIND ERRORS |     |     |     |     |     |
| DTG                                | NO. | LAT            | LONG   | wind            | 00 | 12  | 24  | 36  | 48  | 72  | 00          | 12  | 24  | 36  | 48  | 72  |
| 99091700                           |     | 20.5N          | 129.9E | 20              |    |     |     |     |     |     |             |     |     |     |     |     |
| 99091706                           |     | 20.2N          | 130.0E | 20              |    |     |     |     |     |     |             |     |     |     |     |     |
| 99091712                           | 1   | 20.0N          | 130.1E | 25              | 20 | 25  | 84  | 211 | 327 | 344 | 0           | 0   | 5   | -5  | 0   | -45 |
| 99091718                           | 2   | 19.8N          | 130.3E | 25              | 23 | 36  | 84  | 213 | 277 | 272 | 0           | 0   | 0   | -5  | -10 | -65 |
| 99091800                           | 3   | 19.9N          | 130.5E | 25              | 0  | 34  | 145 | 258 | 256 | 180 | 0           | 0   | -5  | -5  | -30 | -75 |
| 99091806                           | 4   | 20.1N          | 130.3E | 25              | 5  | 57  | 191 | 249 | 239 | 159 | 0           | -5  | -10 | -15 | -45 | -75 |
| 99091812                           | 5   | 20.3N          | 130.0E | 25              | 12 | 128 | 251 | 262 | 247 | 142 | 0           | -10 | -10 | -35 | -50 | -80 |
| 99091818                           | 6   | 20.8N          | 129.3E | 30              | 12 | 151 | 197 | 169 | 128 | 20  | 0           | 0   | 0   | -25 | -40 | -65 |
| 99091900                           | 7   | 21.8N          | 128.2E | 35              | 17 | 65  | 74  | 77  | 105 | 162 | 0           | 10  | -10 | -15 | -40 | -55 |
| 99091906                           | 8   | 22.8N          | 127.1E | 35              | 0  | 63  | 128 | 177 | 221 | 282 | 0           | -5  | -30 | -45 | -45 | -60 |
| 99091912                           | 9   | 23.4N          | 126.2E | 35              | 0  | 66  | 123 | 176 | 237 | 308 | 0           | -20 | -25 | -45 | -45 | -60 |
| 99091918                           | 10  | 23.5N          | 125.6E | 45              | 5  | 69  | 124 | 184 | 238 | 272 | 0           | -25 | -45 | -45 | -55 | -50 |
| 99092000                           | 11  | 23.5N          | 125.4E | 65              | 11 | 55  | 106 | 163 | 195 | 222 | 0           | -10 | -35 | -35 | -45 | -30 |
| 99092006                           | 12  | 23.7N          | 125.3E | 75              | 5  | 24  | 67  | 104 | 126 | 140 | 0           | -10 | -10 | -20 | -25 | -5  |
| 99092012                           | 13  | 24.0N          | 125.3E | 80              | 12 | 60  | 98  | 117 | 154 | 114 | 0           | -20 | -15 | -20 | -25 | -5  |
| 99092018                           | 14  | 24.1N          | 125.3E | 100             | 8  | 40  | 63  | 72  | 96  | 98  | 0           | 0   | -15 | -25 | -20 | 5   |
| 99092100                           | 15  | 24.2N          | 125.4E | 110             | 0  | 24  | 32  | 45  | 68  | 234 | 0           | 0   | -15 | -25 | -10 | 15  |
| 99092106                           | 16  | 24.4N          | 125.7E | 110             | 0  | 23  | 37  | 26  | 36  | 406 | 0           | -15 | -25 | -15 | 0   | 35  |
| 99092112                           | 17  | 24.6N          | 126.1E | 115             | 0  | 12  | 8   | 36  | 50  | 487 | 0           | -15 | -20 | 5   | 15  | -5  |
| 99092118                           | 18  | 25.0N          | 126.6E | 130             | 8  | 11  | 49  | 52  | 25  | 393 | 0           | -10 | -10 | 0   | 0   | 25  |
| 99092200                           | 19  | 25.5N          | 126.9E | 130             | 0  | 36  | 72  | 36  | 50  |     | 0           | -15 | -5  | -5  | -10 |     |
| 99092206                           | 20  | 25.9N          | 127.0E | 140             | 0  | 12  | 21  | 58  | 141 |     | 0           | 10  | 10  | 5   | 10  |     |
| 99092212                           | 21  | 26.3N          | 127.1E | 140             | 0  | 30  | 57  | 120 | 183 |     | 0           | 0   | -10 | -5  | 10  |     |
| 99092218                           | 22  | 27.1N          | 127.1E | 130             | 5  | 32  | 92  | 208 | 278 |     | 0           | 5   | -5  | 10  | 15  |     |
| 99092306                           | 23  | 29.0N          | 127.9E | 110             | 0  | 55  | 265 | 459 |     |     | 0           | 0   | 10  | 15  |     |     |
| 99092312                           | 24  | 30.2N          | 128.6E | 110             | 0  | 128 | 317 |     |     |     | 0           | 5   | 15  |     |     |     |
| 99092318                           | 25  | 32.0N          | 129.8E | 100             | 0  | 75  | 94  |     |     |     | 10          | 10  | 15  |     |     |     |
| 99092400                           | 26  | 34.5N          | 131.5E | 90              | 11 | 15  |     |     |     |     | 0           | 10  |     |     |     |     |
| 99092406                           | 27  | 37.2N          | 134.1E | 70              | 15 | 57  |     |     |     |     | 0           | 5   |     |     |     |     |
| 99092412                           | 28  | 39.5N          | 136.5E | 60              | 62 |     |     |     |     |     | 0           |     |     |     |     |     |
| 99092418                           |     | 41.9N          | 139.8E | 50              |    |     |     |     |     |     |             |     |     |     |     |     |
|                                    |     | AVERAGE        |        |                 | 9  | 51  | 111 | 151 | 167 | 235 | 0           | 8   | 14  | 18  | 25  | 42  |
|                                    |     | BIAS           |        |                 |    |     |     |     |     |     | 0           | -4  | -10 | -15 | -20 | -33 |



| Statistics for JTWC on STY24W Bart |    |    |    |    |    |    |    |    |    |    |    |    |
|------------------------------------|----|----|----|----|----|----|----|----|----|----|----|----|
| #                                  | 28 | 27 | 25 | 23 | 22 | 18 | 28 | 27 | 25 | 23 | 22 | 18 |
| CASES                              |    |    |    |    |    |    |    |    |    |    |    |    |

| Statistics for JTWC on TS 25W Cam |     |                |         |                 |    |    |    |     |     |    |             |    |    |    |    |    |
|-----------------------------------|-----|----------------|---------|-----------------|----|----|----|-----|-----|----|-------------|----|----|----|----|----|
|                                   |     | WRN BEST TRACK |         | POSITION ERRORS |    |    |    |     |     |    | WIND ERRORS |    |    |    |    |    |
| DTG                               | NO. | LAT            | LONG    | wind            | 00 | 12 | 24 | 36  | 48  | 72 | 00          | 12 | 24 | 36 | 48 | 72 |
| 99092300                          |     | 17.6N          | 113.3E  | 20              |    |    |    |     |     |    |             |    |    |    |    |    |
| 99092306                          | 1   | 17.8N          | 113.6E  | 30              | 11 | 34 | 42 | 66  | 99  | 70 | 0           | 0  | 0  | 0  | 5  | 15 |
| 99092312                          | 2   | 18.3N          | 114.1E  | 30              | 16 | 25 | 34 | 58  | 110 | 87 | 0           | 0  | -5 | 5  | 5  | 20 |
| 99092318                          | 3   | 18.7N          | 114.4E  | 30              | 6  | 6  | 33 | 68  | 107 |    | 0           | -5 | -5 | -5 | 10 |    |
| 99092400                          | 4   | 19.1N          | 114.6E  | 30              | 17 | 38 | 61 | 100 | 99  |    | 0           | -5 | 0  | -5 | 10 |    |
| 99092406                          | 5   | 19.4N          | 114.9E  | 35              | 12 | 28 | 63 | 95  | 39  |    | 0           | 0  | 5  | 15 | 10 |    |
| 99092412                          | 6   | 19.9N          | 115.1E  | 40              | 0  | 6  | 54 | 53  | 66  |    | 0           | 10 | 15 | 25 | 20 |    |
| 99092418                          | 7   | 20.4N          | 115.2E  | 40              | 5  | 34 | 69 | 34  |     |    | 0           | 5  | 30 | 20 |    |    |
| 99092500                          | 8   | 20.8N          | 115.3E  | 35              | 0  | 33 | 13 | 69  |     |    | 0           | -5 | 10 | 10 |    |    |
| 99092506                          | 9   | 21.4N          | 115.4E  | 40              | 5  | 28 | 29 |     |     |    | 0           | 15 | 15 |    |    |    |
| 99092512                          | 10  | 22.0N          | 115.5E  | 40              | 0  | 53 | 77 |     |     |    | 0           | 15 | 10 |    |    |    |
| 99092518                          | 11  | 22.2N          | 115.4E  | 25              | 0  | 89 |    |     |     |    | 0           | 0  |    |    |    |    |
| 99092600                          |     | 22.2N          | 114.6E  | 20              |    |    |    |     |     |    |             |    |    |    |    |    |
| 99092606                          |     | 22.8N          | 113.6E  | 20              |    |    |    |     |     |    |             |    |    |    |    |    |
| 99092612                          |     | 23.3N          | 112.7E  | 15              |    |    |    |     |     |    |             |    |    |    |    |    |
|                                   |     |                | AVERAGE |                 | 7  | 34 | 47 | 68  | 87  | 78 | 0           | 5  | 10 | 11 | 10 | 18 |
|                                   |     |                | BIAS    |                 |    |    |    |     |     |    | 0           | 3  | 8  | 8  | 10 | 18 |
|                                   |     |                | #       |                 | 11 | 11 | 10 | 8   | 6   | 2  | 11          | 11 | 10 | 8  | 6  | 2  |
|                                   |     |                | CASES   |                 |    |    |    |     |     |    |             |    |    |    |    |    |

| Statistics for JTWC on TY 26W Dan |     |                |        |                 |    |    |     |     |     |     |             |     |     |     |     |     |
|-----------------------------------|-----|----------------|--------|-----------------|----|----|-----|-----|-----|-----|-------------|-----|-----|-----|-----|-----|
|                                   |     | WRN BEST TRACK |        | POSITION ERRORS |    |    |     |     |     |     | WIND ERRORS |     |     |     |     |     |
| DTG                               | NO. | LAT            | LONG   | wind            | 00 | 12 | 24  | 36  | 48  | 72  | 00          | 12  | 24  | 36  | 48  | 72  |
| 99100112                          |     | 16.2N          | 135.0E | 15              |    |    |     |     |     |     |             |     |     |     |     |     |
| 99100118                          |     | 16.3N          | 134.4E | 15              |    |    |     |     |     |     |             |     |     |     |     |     |
| 99100200                          |     | 16.4N          | 133.7E | 20              |    |    |     |     |     |     |             |     |     |     |     |     |
| 99100206                          |     | 16.6N          | 133.0E | 20              |    |    |     |     |     |     |             |     |     |     |     |     |
| 99100212                          | 1   | 16.8N          | 132.4E | 25              | 0  | 82 | 116 | 183 | 239 | 354 | 0           | -5  | -10 | -15 | -25 | -30 |
| 99100218                          | 2   | 17.2N          | 131.2E | 30              | 20 | 46 | 65  | 114 | 151 | 186 | 0           | 0   | -15 | -20 | -35 | -30 |
| 99100300                          | 3   | 17.6N          | 130.1E | 35              | 0  | 24 | 25  | 48  | 78  | 107 | 0           | -5  | -10 | -20 | -45 | -15 |
| 99100306                          | 4   | 18.1N          | 129.4E | 35              | 0  | 21 | 61  | 93  | 111 | 92  | 0           | -15 | -15 | -30 | -35 | -10 |
| 99100312                          | 5   | 18.4N          | 128.6E | 45              | 6  | 30 | 62  | 100 | 100 | 101 | 0           | -5  | -15 | -40 | -15 | 0   |
| 99100318                          | 6   | 18.3N          | 127.6E | 55              | 12 | 50 | 78  | 116 | 123 | 58  | 0           | 0   | -15 | -20 | -5  | 15  |
| 99100400                          | 7   | 18.3N          | 126.6E | 60              | 6  | 12 | 27  | 62  | 42  | 72  | 0           | -10 | -30 | -10 | 0   | 5   |
| 99100406                          | 8   | 18.3N          | 125.4E | 65              | 0  | 13 | 18  | 21  | 25  | 85  | 0           | -15 | -25 | -10 | 5   | 0   |
| 99100412                          | 9   | 18.3N          | 124.5E | 80              | 6  | 34 | 97  | 69  | 45  | 52  | 0           | -20 | 5   | 10  | 20  | 10  |
| 99100418                          | 10  | 18.2N          | 123.5E | 90              | 0  | 24 | 42  | 70  | 59  | 51  | 0           | -5  | 5   | 15  | 20  | 10  |
| 99100500                          | 11  | 18.2N          | 122.5E | 110             | 0  | 57 | 54  | 70  | 73  | 46  | 0           | -5  | 0   | 10  | 10  | -5  |
| 99100506                          | 12  | 18.4N          | 121.3E | 100             | 0  | 21 | 60  | 73  | 91  | 87  | 0           | 0   | 10  | 15  | 5   | -5  |

| Statistics for JTWC on TY 26W Dan |    |       |        |    |    |    |     |     |     |     |    |     |     |     |     |     |
|-----------------------------------|----|-------|--------|----|----|----|-----|-----|-----|-----|----|-----|-----|-----|-----|-----|
| 99100512                          | 13 | 18.5N | 120.0E | 90 | 0  | 58 | 75  | 107 | 143 | 164 | 0  | 10  | 15  | 15  | 10  | -5  |
| 99100518                          | 14 | 18.5N | 119.7E | 90 | 0  | 29 | 8   | 72  | 110 | 183 | 0  | 15  | 15  | -5  | -10 | -20 |
| 99100600                          | 15 | 18.5N | 118.9E | 85 | 0  | 12 | 58  | 121 | 168 | 254 | 0  | 15  | 10  | 0   | -10 | -20 |
| 99100606                          | 16 | 18.6N | 118.4E | 80 | 0  | 41 | 105 | 162 | 194 | 280 | 0  | 10  | 5   | 0   | -10 | -5  |
| 99100612                          | 17 | 18.9N | 118.0E | 80 | 18 | 79 | 141 | 176 | 212 | 273 | 0  | 5   | 0   | -10 | -20 | 0   |
| 99100618                          | 18 | 19.4N | 117.8E | 80 | 8  | 63 | 118 | 152 | 197 | 267 | 0  | 0   | 0   | -15 | -25 | -10 |
| 99100700                          | 19 | 19.7N | 117.9E | 85 | 28 | 75 | 118 | 166 | 200 | 339 | 0  | 0   | 0   | -15 | -45 | -5  |
| 99100706                          | 20 | 20.2N | 118.1E | 90 | 5  | 28 | 50  | 110 | 147 | 279 | 0  | 0   | 0   | -15 | -35 | -5  |
| 99100712                          | 21 | 20.6N | 118.2E | 90 | 8  | 6  | 57  | 100 | 149 | 293 | 0  | 0   | 0   | -15 | -15 | -5  |
| 99100718                          | 22 | 21.3N | 118.2E | 90 | 5  | 21 | 41  | 71  | 138 |     | 0  | -15 | -30 | -40 | -15 |     |
| 99100800                          | 23 | 21.8N | 118.1E | 90 | 0  | 26 | 38  | 89  | 202 |     | 0  | -10 | -30 | -20 | -5  |     |
| 99100806                          | 24 | 22.3N | 118.0E | 90 | 0  | 34 | 63  | 134 | 218 |     | 0  | 0   | -10 | 0   | -5  |     |
| 99100812                          | 25 | 22.6N | 118.2E | 90 | 0  | 12 | 20  | 77  | 165 |     | 0  | 0   | 5   | 10  | -5  |     |
| 99100818                          | 26 | 23.3N | 118.2E | 90 | 0  | 21 | 72  | 92  | 244 |     | 0  | 10  | 30  | 20  | 0   |     |
| 99100900                          | 27 | 24.0N | 118.1E | 90 | 5  | 11 | 8   | 37  | 106 |     | -5 | 10  | 20  | 0   | 0   |     |
| 99100906                          | 28 | 24.6N | 118.0E | 75 | 6  | 20 | 74  | 166 |     |     | 0  | 20  | 10  | 5   |     |     |
| 99100912                          | 29 | 25.5N | 118.1E | 55 | 18 | 49 | 57  | 70  |     |     | 0  | 10  | 0   | 0   |     |     |
| 99100918                          | 30 | 26.4N | 118.3E | 35 | 6  | 32 | 114 |     |     |     | 0  | 0   | 0   |     |     |     |
| 99101000                          | 31 | 27.2N | 119.1E | 25 | 0  | 8  | 119 |     |     |     | 0  | -5  | 0   |     |     |     |
| 99101006                          | 32 | 28.1N | 120.0E | 25 | 16 | 29 |     |     |     |     | 0  | 0   |     |     |     |     |
| 99101012                          | 33 | 29.5N | 121.2E | 25 | 44 | 8  |     |     |     |     | 0  | 0   |     |     |     |     |
| 99101018                          | 34 | 31.1N | 123.4E | 20 | 0  |    |     |     |     |     | 0  |     |     |     |     |     |
| 99101100                          | 35 | 33.1N | 125.4E | 20 | 0  |    |     |     |     |     | 0  |     |     |     |     |     |
| AVERAGE                           |    |       |        |    | 6  | 33 | 66  | 101 | 138 | 173 | 0  | 7   | 11  | 14  | 16  | 10  |
| BIAS                              |    |       |        |    |    |    |     |     |     |     | 0  | 0   | -2  | -7  | -11 | -6  |
| # CASES                           |    |       |        |    | 35 | 33 | 31  | 29  | 27  | 21  | 35 | 33  | 31  | 29  | 27  | 21  |

| Statistics for JTWC on TS 27W Eve |     |            |        |                 |    |    |     |     |     |     |             |    |     |     |     |    |
|-----------------------------------|-----|------------|--------|-----------------|----|----|-----|-----|-----|-----|-------------|----|-----|-----|-----|----|
|                                   | WRN | BEST TRACK |        | POSITION ERRORS |    |    |     |     |     |     | WIND ERRORS |    |     |     |     |    |
| DTG                               | NO. | LAT        | LONG   | wind            | 00 | 12 | 24  | 36  | 48  | 72  | 00          | 12 | 24  | 36  | 48  | 72 |
| 99101418                          |     | 11.8N      | 129.3E | 20              |    |    |     |     |     |     |             |    |     |     |     |    |
| 99101500                          |     | 11.6N      | 128.5E | 20              |    |    |     |     |     |     |             |    |     |     |     |    |
| 99101506                          | 1   | 11.3N      | 127.6E | 25              | 8  | 58 | 196 | 275 | 301 | 365 | 0           | 0  | 0   | 0   | 0   | 0  |
| 99101512                          | 2   | 11.3N      | 126.4E | 25              | 0  | 61 | 149 | 182 | 208 | 224 | 0           | 0  | 0   | -5  | 0   | 0  |
| 99101518                          | 3   | 11.7N      | 125.5E | 25              | 0  | 40 | 49  | 84  | 151 | 81  | 0           | 0  | 0   | -5  | 0   | 0  |
| 99101600                          | 4   | 12.6N      | 124.0E | 25              | 18 | 43 | 44  | 94  | 101 | 122 | 0           | 0  | -5  | 0   | 0   | -5 |
| 99101606                          | 5   | 13.4N      | 122.4E | 25              | 0  | 13 | 68  | 141 | 76  | 97  | 0           | 0  | -5  | 0   | 0   | -5 |
| 99101612                          | 6   | 14.2N      | 121.2E | 25              | 0  | 52 | 120 | 112 | 32  | 110 | 0           | -5 | 0   | 0   | 0   | 0  |
| 99101618                          | 7   | 14.7N      | 120.1E | 25              | 13 | 54 | 121 | 51  | 39  | 94  | 0           | -5 | 0   | 0   | 0   | 5  |
| 99101700                          | 8   | 15.3N      | 119.4E | 30              | 25 | 83 | 84  | 26  | 59  |     | 0           | 0  | 0   | -5  | -10 |    |
| 99101706                          | 9   | 15.9N      | 118.8E | 30              | 30 | 79 | 32  | 42  | 80  |     | 0           | 0  | 0   | -5  | -10 |    |
| 99101712                          | 10  | 16.6N      | 118.2E | 30              | 42 | 67 | 98  | 110 | 113 |     | 0           | 0  | -5  | -10 | -5  |    |
| 99101718                          | 11  | 17.4N      | 117.3E | 30              | 36 | 59 | 125 | 187 | 182 |     | 0           | 0  | 0   | -10 | 0   |    |
| 99101800                          | 12  | 17.3N      | 115.9E | 30              | 25 | 92 | 158 | 205 |     |     | 0           | 0  | -5  | -5  |     |    |
| 99101806                          | 13  | 17.1N      | 114.3E | 30              | 11 | 24 | 23  | 79  |     |     | 0           | -5 | -10 | -5  |     |    |

| Statistics for JTWC on TS 27W Eve |    |       |         |    |    |     |    |     |     |     |     |    |    |    |    |    |
|-----------------------------------|----|-------|---------|----|----|-----|----|-----|-----|-----|-----|----|----|----|----|----|
| 99101812                          | 14 | 16.9N | 112.8E  | 30 | 20 | 32  | 33 |     |     | 0   | -10 | -5 |    |    |    |    |
| 99101818                          | 15 | 16.4N | 111.4E  | 30 | 12 | 36  | 42 |     |     | 5   | -5  | 0  |    |    |    |    |
| 99101900                          | 16 | 16.1N | 110.3E  | 35 | 50 | 66  |    |     |     | 10  | 0   |    |    |    |    |    |
| 99101906                          | 17 | 15.7N | 108.8E  | 35 | 24 | 138 |    |     |     | 0   | -5  |    |    |    |    |    |
| 99101912                          | 18 | 16.2N | 107.5E  | 30 | 18 |     |    |     |     | 0   |     |    |    |    |    |    |
| 99101918                          |    | 16.8N | 106.6E  | 25 |    |     |    |     |     |     |     |    |    |    |    |    |
|                                   |    |       | AVERAGE |    | 19 | 59  | 89 | 122 | 122 | 156 | 1   | 2  | 2  | 4  | 2  | 2  |
|                                   |    |       | BIAS    |    |    |     |    |     |     |     | 1   | -2 | -2 | -4 | -2 | -1 |
|                                   |    |       | # CASES |    | 18 | 17  | 15 | 13  | 11  | 7   | 18  | 17 | 15 | 13 | 11 | 7  |

| Statistics for JTWC on TD 28W |     |                |         |                 |    |     |    |    |    |    |             |    |    |    |    |    |
|-------------------------------|-----|----------------|---------|-----------------|----|-----|----|----|----|----|-------------|----|----|----|----|----|
|                               |     | WRN BEST TRACK |         | POSITION ERRORS |    |     |    |    |    |    | WIND ERRORS |    |    |    |    |    |
| DTG                           | NO. | LAT            | LONG    | wind            | 00 | 12  | 24 | 36 | 48 | 72 | 00          | 12 | 24 | 36 | 48 | 72 |
| 99110500                      |     | 17.8N          | 146.7E  | 20              |    |     |    |    |    |    |             |    |    |    |    |    |
| 99110506                      |     | 17.8N          | 146.5E  | 20              |    |     |    |    |    |    |             |    |    |    |    |    |
| 99110512                      |     | 17.9N          | 146.3E  | 25              |    |     |    |    |    |    |             |    |    |    |    |    |
| 99110518                      | 1   | 18.3N          | 146.2E  | 30              | 11 | 131 |    |    |    |    | 0           | 5  |    |    |    |    |
| 99110600                      | 2   | 19.1N          | 146.6E  | 30              | 61 | 238 |    |    |    |    | 0           | 15 |    |    |    |    |
| 99110606                      | 3   | 20.2N          | 147.3E  | 30 1            | 78 |     |    |    |    |    | 0           |    |    |    |    |    |
| 99110612                      | 4   | 21.4N          | 148.8E  | 20 3            | 44 |     |    |    |    |    | 5           |    |    |    |    |    |
|                               |     |                | AVERAGE |                 | 49 | 185 |    |    |    |    | 1           | 10 |    |    |    |    |
|                               |     |                | 1       |                 |    |     |    |    |    |    |             |    |    |    |    |    |
|                               |     |                | BIAS    |                 |    |     |    |    |    |    | 1           | 10 |    |    |    |    |
|                               |     |                | # CASES |                 | 4  | 2   |    |    |    |    | 4           | 2  |    |    |    |    |

| Statistics for JTWC on TS 29W Frankie |     |                |        |                 |    |     |     |     |     |     |             |     |     |     |    |    |
|---------------------------------------|-----|----------------|--------|-----------------|----|-----|-----|-----|-----|-----|-------------|-----|-----|-----|----|----|
|                                       |     | WRN BEST TRACK |        | POSITION ERRORS |    |     |     |     |     |     | WIND ERRORS |     |     |     |    |    |
| DTG                                   | NO. | LAT            | LONG   | wind            | 00 | 12  | 24  | 36  | 48  | 72  | 00          | 12  | 24  | 36  | 48 | 72 |
| 99110518                              |     | 9.4N           | 137.7E | 15              |    |     |     |     |     |     |             |     |     |     |    |    |
| 99110600                              |     | 10.2N          | 136.4E | 20              |    |     |     |     |     |     |             |     |     |     |    |    |
| 99110606                              | 1   | 11.0N          | 134.9E | 25              | 0  | 144 | 245 | 300 | 375 | 282 | 0           | 5   | 5   | 10  | 0  | 10 |
| 99110612                              | 2   | 11.3N          | 133.0E | 25              | 18 | 90  | 132 | 81  | 108 | 47  | 5           | 5   | 10  | 5   | 5  | 15 |
| 99110618                              | 3   | 11.0N          | 131.8E | 25              | 8  | 17  | 43  | 179 | 209 | 141 | 0           | 0   | 0   | -10 | 0  | 10 |
| 99110700                              | 4   | 10.8N          | 130.8E | 25              | 0  | 21  | 94  | 173 | 147 | 70  | 0           | 0   | -5  | -5  | -5 | 10 |
| 99110706                              | 5   | 10.2N          | 129.5E | 25              | 0  | 73  | 202 | 189 | 136 | 78  | 0           | 0   | -10 | 0   | 0  | 15 |
| 99110712                              | 6   | 10.2N          | 128.6E | 25              | 0  | 118 | 227 | 195 | 152 |     | 0           | -5  | -10 | 0   | 5  |    |
| 99110718                              | 7   | 10.9N          | 126.9E | 25              | 0  | 109 | 127 | 68  | 70  |     | 0           | -10 | -5  | -5  | 0  |    |
| 99110800                              | 8   | 11.4N          | 126.0E | 30              | 0  | 115 | 70  | 39  | 119 |     | 0           | -10 | -10 | -5  | 5  |    |
| 99110806                              | 9   | 12.4N          | 124.1E | 35              | 24 | 64  | 174 | 268 | 356 |     | 0           | 5   | 5   | 15  | 25 |    |
| 99110812                              | 10  | 12.2N          | 123.2E | 35              | 44 | 195 | 359 | 491 |     |     | 0           | 0   | 10  | 20  |    |    |
| 99110818                              | 11  | 12.2N          | 122.8E | 30              | 13 | 94  | 199 | 287 |     |     | 0           | 0   | 10  | 25  |    |    |
| 99110900                              | 12  | 12.1N          | 122.7E | 30              | 0  | 71  | 123 |     |     |     | 0           | 5   | 10  |     |    |    |
| 99110906                              | 13  | 12.4N          | 123.2E | 30              | 8  | 18  | 65  |     |     |     | 0           | 0   | 10  |     |    |    |

| Statistics for JTWC on TS 29W Frankie |    |         |        |    |    |    |     |     |     |     |    |    |    |    |   |    |
|---------------------------------------|----|---------|--------|----|----|----|-----|-----|-----|-----|----|----|----|----|---|----|
| 99110912                              | 14 | 12.6N   | 123.4E | 25 | 0  | 17 |     |     | 0   | 5   |    |    |    |    |   |    |
| 99110918                              | 15 | 12.7N   | 123.5E | 25 | 0  | 6  |     |     | 0   | 5   |    |    |    |    |   |    |
| 99111000                              | 16 | 12.9N   | 123.6E | 20 | 5  |    |     |     | 0   |     |    |    |    |    |   |    |
| 99111006                              |    | 13.1N   | 123.7E | 15 |    |    |     |     |     |     |    |    |    |    |   |    |
|                                       |    | AVERAGE |        |    | 8  | 77 | 158 | 206 | 186 | 124 | 0  | 4  | 8  | 9  | 5 | 12 |
|                                       |    | BIAS    |        |    |    |    |     |     |     |     | 0  | 0  | 2  | 5  | 4 | 12 |
|                                       |    | #       |        |    | 16 | 15 | 13  | 11  | 9   | 5   | 16 | 15 | 13 | 11 | 9 | 5  |
|                                       |    | CASES   |        |    |    |    |     |     |     |     |    |    |    |    |   |    |

| Statistics for JTWC on TY 30W Gloria |     |         |        |                 |     |     |     |      |     |             |     |     |     |     |     |    |
|--------------------------------------|-----|---------|--------|-----------------|-----|-----|-----|------|-----|-------------|-----|-----|-----|-----|-----|----|
|                                      |     | WRN     | BEST   | POSITION ERRORS |     |     |     |      |     | WIND ERRORS |     |     |     |     |     |    |
| DTG                                  | NO. | LAT     | LONG   | wind            | 00  | 12  | 24  | 36   | 48  | 72          | 00  | 12  | 24  | 36  | 48  | 72 |
| 99111012                             |     | 12.9N   | 126.6E | 15              |     |     |     |      |     |             |     |     |     |     |     |    |
| 99111018                             |     | 12.6N   | 126.7E | 15              |     |     |     |      |     |             |     |     |     |     |     |    |
| 99111100                             |     | 12.3N   | 126.9E | 15              |     |     |     |      |     |             |     |     |     |     |     |    |
| 99111106                             |     | 11.4N   | 127.8E | 15              |     |     |     |      |     |             |     |     |     |     |     |    |
| 99111112                             |     | 10.5N   | 129.0E | 15              |     |     |     |      |     |             |     |     |     |     |     |    |
| 99111118                             |     | 10.4N   | 129.8E | 20              |     |     |     |      |     |             |     |     |     |     |     |    |
| 99111200                             |     | 10.3N   | 130.5E | 20              |     |     |     |      |     |             |     |     |     |     |     |    |
| 99111206                             |     | 10.7N   | 131.0E | 20              |     |     |     |      |     |             |     |     |     |     |     |    |
| 99111212                             |     | 11.0N   | 131.1E | 20              |     |     |     |      |     |             |     |     |     |     |     |    |
| 99111218                             |     | 11.7N   | 131.6E | 20              |     |     |     |      |     |             |     |     |     |     |     |    |
| 99111300                             |     | 13.3N   | 131.9E | 20              |     |     |     |      |     |             |     |     |     |     |     |    |
| 99111306                             | 1   | 14.7N   | 132.1E | 25              | 52  | 76  | 133 | 267  | 467 | 1431        | 0   | 0   | -5  | 0   | 5   | -5 |
| 99111312                             | 2   | 15.7N   | 131.9E | 30              | 26  | 19  | 93  | 197  | 405 |             | 0   | 5   | 0   | 10  | -10 |    |
| 99111318                             | 3   | 16.6N   | 131.3E | 30              | 33  | 60  | 80  | 142  | 434 |             | 0   | -5  | -5  | 0   | -25 |    |
| 99111400                             | 4   | 17.5N   | 130.8E | 30              | 54  | 63  | 61  | 243  | 278 |             | 0   | -10 | -5  | -15 | -25 |    |
| 99111406                             | 5   | 18.5N   | 130.4E | 40              | 0   | 54  | 195 | 513  | 900 |             | 0   | 0   | -10 | -40 | -30 |    |
| 99111412                             | 6   | 20.0N   | 130.3E | 45              | 0   | 73  | 275 | 627  |     |             | 0   | 0   | -25 | -35 |     |    |
| 99111418                             | 7   | 21.0N   | 130.5E | 45              | 0   | 51  | 252 | 339  |     |             | 0   | -10 | -35 | -35 |     |    |
| 99111500                             | 8   | 22.4N   | 131.3E | 45              | 6   | 81  | 295 |      |     |             | 0   | -25 | -35 |     |     |    |
| 99111506                             | 9   | 23.9N   | 132.3E | 45              | 17  | 186 | 418 |      |     |             | 0   | -25 | -20 |     |     |    |
| 99111512                             | 10  | 25.8N   | 134.9E | 60              | 43  | 226 |     |      |     |             | -20 | -30 |     |     |     |    |
| 99111518                             | 11  | 27.9N   | 138.2E | 65              | 36  | 156 |     |      |     |             | 0   | -5  |     |     |     |    |
| 99111600                             | 12  | 30.1N   | 142.1E | 65              | 38  |     |     |      |     |             | 0   |     |     |     |     |    |
| 99111606                             | 13  | 32.5N   | 147.1E | 55              | 52  |     |     |      |     |             | 0   |     |     |     |     |    |
|                                      |     | AVERAGE | 28     | 95              | 200 | 332 | 497 | 1431 |     |             | 2   | 10  | 16  | 19  | 19  | 5  |
|                                      |     | BIAS    |        |                 |     |     |     |      |     |             | -2  | -10 | -16 | -16 | -17 | -5 |
|                                      |     | #       | 13     | 11              | 9   | 7   | 5   | 1    |     |             | 13  | 11  | 9   | 7   | 5   | 1  |
|                                      |     | CASES   |        |                 |     |     |     |      |     |             |     |     |     |     |     |    |

| Statistics for JTWC on TD 31W |     |       |        |                 |    |    |    |    |    |             |    |    |    |    |    |    |
|-------------------------------|-----|-------|--------|-----------------|----|----|----|----|----|-------------|----|----|----|----|----|----|
|                               |     | WRN   | BEST   | POSITION ERRORS |    |    |    |    |    | WIND ERRORS |    |    |    |    |    |    |
| DTG                           | NO. | LAT   | LONG   | wind            | 00 | 12 | 24 | 36 | 48 | 72          | 00 | 12 | 24 | 36 | 48 | 72 |
| 99112912                      |     | 10.5N | 117.5E | 15              |    |    |    |    |    |             |    |    |    |    |    |    |

| Statistics for JTWC on TD 31W |    |       |        |    |    |     |     |     |     |     |    |     |     |     |     |     |
|-------------------------------|----|-------|--------|----|----|-----|-----|-----|-----|-----|----|-----|-----|-----|-----|-----|
| 99112918                      |    | 10.8N | 116.5E | 15 |    |     |     |     |     |     |    |     |     |     |     |     |
| 99113000                      |    | 11.3N | 115.1E | 15 |    |     |     |     |     |     |    |     |     |     |     |     |
| 99113006                      |    | 11.7N | 113.8E | 20 |    |     |     |     |     |     |    |     |     |     |     |     |
| 99113012                      |    | 11.7N | 112.8E | 20 |    |     |     |     |     |     |    |     |     |     |     |     |
| 99113018                      |    | 11.5N | 112.0E | 20 |    |     |     |     |     |     |    |     |     |     |     |     |
| 99120100                      | 1  | 11.2N | 111.2E | 30 | 13 | 56  | 199 | 245 | 232 | 342 | 0  | 0   | 5   | 0   | -5  | -10 |
| 99120106                      | 2  | 10.7N | 110.5E | 30 | 21 | 138 | 247 | 249 | 232 | 309 | 0  | 5   | 5   | 0   | -10 | -10 |
| 99120112                      | 3  | 9.8N  | 109.7E | 30 | 61 | 203 | 246 | 234 | 233 |     | 0  | 0   | 0   | -10 | -10 |     |
| 99120118                      | 4  | 8.5N  | 108.9E | 25 | 1  | 36  | 236 | 227 | 219 | 268 | 5  | 0   | 0   | -10 | -10 |     |
| 99120200                      | 5  | 7.3N  | 108.0E | 25 | 1  | 93  | 224 | 207 | 221 | 295 | 0  | 0   | -10 | -5  | -5  |     |
| 99120206                      | 6  | 6.7N  | 107.0E | 25 |    | 5   | 36  | 54  | 87  | 119 | 0  | 0   | -10 | -5  | -10 |     |
| 99120212                      | 7  | 6.8N  | 106.0E | 25 |    | 12  | 43  | 42  | 67  | 90  | 0  | -5  | 0   | -5  | -10 |     |
| 99120218                      | 8  | 7.0N  | 105.2E | 25 |    | 29  | 49  | 105 | 186 |     | 0  | -5  | -5  | -10 |     |     |
| 99120300                      | 9  | 7.2N  | 104.6E | 30 |    | 18  | 37  | 100 | 137 |     | 0  | 0   | -5  | -10 |     |     |
| 99120306                      | 10 | 7.4N  | 103.9E | 30 |    | 0   | 61  | 98  | 51  | 96  | 0  | 5   | 5   | 0   | 0   |     |
| 99120312                      | 11 | 7.8N  | 102.8E | 25 |    | 11  | 45  | 48  | 89  |     | 5  | 0   | -5  | 0   |     |     |
| 99120318                      | 12 | 8.2N  | 101.5E | 25 |    | 5   | 66  | 148 |     |     | 0  | -5  | -10 |     |     |     |
| 99120400                      | 13 | 8.8N  | 100.5E | 25 |    | 30  | 80  |     |     |     | -5 | -10 |     |     |     |     |
| 99120406                      |    | 9.6N  | 99.7E  | 25 |    |     |     |     |     |     |    |     |     |     |     |     |
| 99120412                      |    | 9.8N  | 99.4E  | 25 |    |     |     |     |     |     |    |     |     |     |     |     |
| 99120418                      |    | 10.1N | 99.1E  | 25 |    |     |     |     |     |     |    |     |     |     |     |     |
| 99120500                      |    | 10.8N | 98.3E  | 20 |    |     |     |     |     |     |    |     |     |     |     |     |
| 99120506                      |    | 11.9N | 97.1E  | 20 |    |     |     |     |     |     |    |     |     |     |     |     |
| AVERAGE                       |    |       |        |    | 42 | 98  | 143 | 162 | 196 | 326 | 1  | 3   | 5   | 5   | 8   | 10  |
| BIAS                          |    |       |        |    |    |     |     |     |     |     | 0  | -1  | -3  | -5  | -8  | -10 |
| # CASES                       |    |       |        |    | 13 | 13  | 12  | 11  | 8   | 2   | 13 | 13  | 12  | 11  | 8   | 2   |

| Statistics for JTWC on TD 32W |     |      |        |            |    |                 |     |    |    |    |    |             |    |    |    |    |  |
|-------------------------------|-----|------|--------|------------|----|-----------------|-----|----|----|----|----|-------------|----|----|----|----|--|
|                               |     | WRN  |        | BEST TRACK |    | POSITION ERRORS |     |    |    |    |    | WIND ERRORS |    |    |    |    |  |
| DTG                           | NO. | LAT  | LONG   | wind       | 00 | 12              | 24  | 36 | 48 | 72 | 00 | 12          | 24 | 36 | 48 | 72 |  |
| 99120712                      |     | 7.9N | 116.0E | 20         |    |                 |     |    |    |    |    |             |    |    |    |    |  |
| 99120718                      |     | 7.9N | 115.4E | 20         |    |                 |     |    |    |    |    |             |    |    |    |    |  |
| 99120800                      |     | 7.9N | 114.9E | 20         |    |                 |     |    |    |    |    |             |    |    |    |    |  |
| 99120806                      |     | 7.9N | 114.6E | 20         |    |                 |     |    |    |    |    |             |    |    |    |    |  |
| 99120812                      |     | 7.8N | 114.1E | 20         |    |                 |     |    |    |    |    |             |    |    |    |    |  |
| 99120818                      |     | 7.7N | 113.6E | 20         |    |                 |     |    |    |    |    |             |    |    |    |    |  |
| 99120900                      |     | 7.6N | 113.2E | 20         |    |                 |     |    |    |    |    |             |    |    |    |    |  |
| 99120906                      |     | 7.5N | 112.8E | 20         |    |                 |     |    |    |    |    |             |    |    |    |    |  |
| 99120912                      |     | 7.5N | 112.4E | 20         |    |                 |     |    |    |    |    |             |    |    |    |    |  |
| 99120918                      | 1   | 7.5N | 112.0E | 25         | 13 | 51              | 46  | 76 |    |    | 0  | 0           | 0  | 10 |    |    |  |
| 99121000                      | 2   | 7.5N | 111.1E | 30         | 21 | 51              | 51  |    |    |    | 0  | 0           | 10 |    |    |    |  |
| 99121006                      | 3   | 7.5N | 110.0E | 30         | 16 | 48              | 120 |    |    |    | 0  | 0           | 10 |    |    |    |  |
| 99121012                      | 4   | 7.4N | 109.1E | 30         | 18 | 78              |     |    |    |    | 0  | 10          |    |    |    |    |  |
| 99121018                      | 5   | 7.2N | 108.6E | 30         | 8  | 74              |     |    |    |    | 0  | 10          |    |    |    |    |  |
| 99121100                      | 6   | 7.1N | 108.3E | 20         | 32 |                 |     |    |    |    | 0  |             |    |    |    |    |  |

| Statistics for JTWC on TD 32W |      |         |    |    |    |    |  |  |   |   |   |    |
|-------------------------------|------|---------|----|----|----|----|--|--|---|---|---|----|
| 99121106                      | 7.0N | 108.0E  | 20 |    |    |    |  |  |   |   |   |    |
|                               |      | AVERAGE | 19 | 60 | 72 | 76 |  |  | 0 | 4 | 7 | 10 |
|                               |      | BIAS    |    |    |    |    |  |  | 0 | 4 | 7 | 10 |
|                               |      | #       | 6  | 5  | 3  | 1  |  |  | 6 | 5 | 3 | 1  |
|                               |      | CASES   |    |    |    |    |  |  |   |   |   |    |

| Statistics for JTWC on TD 33W |     |         |        |                 |    |     |     |     |    |    |             |    |     |     |    |    |
|-------------------------------|-----|---------|--------|-----------------|----|-----|-----|-----|----|----|-------------|----|-----|-----|----|----|
|                               |     | WRN     | BEST   | POSITION ERRORS |    |     |     |     |    |    | WIND ERRORS |    |     |     |    |    |
| DTG                           | NO. | LAT     | LONG   | wind            | 00 | 12  | 24  | 36  | 48 | 72 | 00          | 12 | 24  | 36  | 48 | 72 |
| 99121400                      |     | 11.6N   | 114.5E | 20              |    |     |     |     |    |    |             |    |     |     |    |    |
| 99121406                      |     | 11.7N   | 113.8E | 20              |    |     |     |     |    |    |             |    |     |     |    |    |
| 99121412                      | 1   | 12.0N   | 112.9E | 25              | 17 | 55  | 155 | 212 |    |    | 0           | 0  | -5  | -10 |    |    |
| 99121418                      | 2   | 12.1N   | 112.1E | 30              | 30 | 110 | 158 | 184 |    |    | 0           | 0  | -5  | 0   |    |    |
| 99121500                      | 3   | 11.9N   | 111.4E | 30              | 53 | 127 | 164 |     |    |    | 0           | -5 | -10 |     |    |    |
| 99121506                      | 4   | 11.6N   | 110.9E | 30              | 17 | 65  | 149 |     |    |    | 0           | -5 | 0   |     |    |    |
| 99121512                      | 5   | 11.6N   | 110.3E | 30              | 11 | 30  |     |     |    |    | 0           | 0  |     |     |    |    |
| 99121518                      | 6   | 11.7N   | 109.8E | 30              | 0  | 59  |     |     |    |    | 0           | 10 |     |     |    |    |
| 99121600                      | 7   | 12.1N   | 109.3E | 25              | 16 |     |     |     |    |    | 0           |    |     |     |    |    |
| 99121606                      |     | 12.7N   | 109.1E | 15              |    |     |     |     |    |    |             |    |     |     |    |    |
|                               |     | AVERAGE |        |                 | 21 | 74  | 156 | 198 |    |    | 0           | 3  | 5   | 5   |    |    |
|                               |     | BIAS    |        |                 |    |     |     |     |    |    | 0           | 0  | -5  | -5  |    |    |
|                               |     | #       |        |                 | 7  | 6   | 4   | 2   |    |    | 7           | 6  | 4   | 2   |    |    |
|                               |     | CASES   |        |                 |    |     |     |     |    |    |             |    |     |     |    |    |

| Statistics for JTWC on HUR07E Dora |     |       |        |                 |    |    |    |    |    |    |             |    |    |    |    |    |
|------------------------------------|-----|-------|--------|-----------------|----|----|----|----|----|----|-------------|----|----|----|----|----|
|                                    |     | WRN   | BEST   | POSITION ERRORS |    |    |    |    |    |    | WIND ERRORS |    |    |    |    |    |
| DTG                                | NO. | LAT   | LONG   | wind            | 00 | 12 | 24 | 36 | 48 | 72 | 00          | 12 | 24 | 36 | 48 | 72 |
| 99080500                           |     | 10.8N | 95.5W  | 25              |    |    |    |    |    |    |             |    |    |    |    |    |
| 99080506                           |     | 10.8N | 96.7W  | 25              |    |    |    |    |    |    |             |    |    |    |    |    |
| 99080512                           |     | 11.4N | 97.9W  | 25              |    |    |    |    |    |    |             |    |    |    |    |    |
| 99080518                           |     | 11.8N | 99.2W  | 30              |    |    |    |    |    |    |             |    |    |    |    |    |
| 99080600                           | 1   | 12.2N | 100.7W | 30              | 0  |    |    |    |    |    | 0           |    |    |    |    |    |
| 99080606                           | 2   | 12.3N | 102.2W | 30              | 5  |    |    |    |    |    | 0           |    |    |    |    |    |
| 99080612                           | 3   | 12.6N | 103.6W | 30              | 18 |    |    |    |    |    | 0           |    |    |    |    |    |
| 99080618                           | 4   | 13.1N | 105.0W | 35              | 5  |    |    |    |    |    | 0           |    |    |    |    |    |
| 99080700                           | 5   | 13.6N | 106.4W | 35              | 5  |    |    |    |    |    | 10          |    |    |    |    |    |
| 99080706                           | 6   | 14.1N | 107.6W | 40              | 16 |    |    |    |    |    | 5           |    |    |    |    |    |
| 99080712                           | 7   | 14.5N | 108.4W | 45              | 8  |    |    |    |    |    | 0           |    |    |    |    |    |
| 99080718                           | 8   | 14.9N | 108.9W | 50              | 29 |    |    |    |    |    | 0           |    |    |    |    |    |
| 99080800                           | 9   | 15.2N | 109.8W | 55              | 13 |    |    |    |    |    | 5           |    |    |    |    |    |
| 99080806                           | 10  | 15.2N | 111.0W | 60              | 21 |    |    |    |    |    | 5           |    |    |    |    |    |
| 99080812                           | 11  | 15.1N | 112.2W | 65              | 29 |    |    |    |    |    | 0           |    |    |    |    |    |
| 99080818                           | 12  | 15.0N | 113.2W | 75              | 11 |    |    |    |    |    | 0           |    |    |    |    |    |
| 99080900                           | 13  | 14.9N | 114.1W | 85              | 6  |    |    |    |    |    | 5           |    |    |    |    |    |
| 99080906                           | 14  | 14.8N | 115.2W | 90              | 0  |    |    |    |    |    | 0           |    |    |    |    |    |

|                                    |    |       |           |    |    |    |    |     |     |   |   |    |    |    |    |
|------------------------------------|----|-------|-----------|----|----|----|----|-----|-----|---|---|----|----|----|----|
| Statistics for JTWC on HUR07E Dora |    |       |           |    |    |    |    |     |     |   |   |    |    |    |    |
| 99080912                           | 15 | 14.6N | 115.9W90  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99080918                           | 16 | 14.5N | 116.8W90  | 0  |    |    |    |     |     |   |   |    |    |    | 5  |
| 99081000                           | 17 | 14.4N | 117.6W100 | 8  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081006                           | 18 | 14.4N | 118.5W105 | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081012                           | 19 | 14.3N | 119.4W110 | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081018                           | 20 | 14.4N | 120.4W115 | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081100                           | 21 | 14.5N | 121.5W115 | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081106                           | 22 | 14.6N | 122.6W115 | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081112                           | 23 | 14.6N | 123.8W115 | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081118                           | 24 | 14.8N | 125.0W115 | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081200                           | 25 | 14.9N | 126.4W120 | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081206                           | 26 | 15.0N | 127.7W115 | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081212                           | 27 | 15.2N | 129.1W115 | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081218                           | 28 | 15.5N | 130.5W120 | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081300                           | 29 | 15.5N | 132.2W115 | 0  |    |    |    |     |     |   |   |    |    |    | 5  |
| 99081306                           | 30 | 15.5N | 133.9W120 | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081312                           | 31 | 15.5N | 135.7W115 | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081318                           | 32 | 15.5N | 137.6W110 | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081400                           | 33 | 15.6N | 139.7W100 | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081406                           | 34 | 15.5N | 141.8W85  | 5  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081412                           | 35 | 15.5N | 143.3W70  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081418                           | 36 | 15.2N | 145.4W70  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081500                           | 37 | 15.2N | 147.2W70  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081506                           | 38 | 15.5N | 149.0W90  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081512                           | 39 | 15.6N | 150.8W95  | 6  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081518                           | 40 | 15.6N | 152.5W95  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081600                           | 41 | 15.8N | 154.3W95  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081606                           | 42 | 15.9N | 156.6W100 | 40 |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081612                           | 43 | 15.7N | 157.7W90  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081618                           | 44 | 15.5N | 159.1W85  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081700                           | 45 | 15.5N | 160.8W75  | 5  |    |    |    |     |     |   |   |    |    |    | 5  |
| 99081706                           | 46 | 15.6N | 162.8W75  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081712                           | 47 | 15.5N | 164.0W75  | 5  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081718                           | 48 | 15.5N | 166.0W70  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081800                           | 49 | 15.6N | 167.8W65  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081806                           | 50 | 15.6N | 169.5W65  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081812                           | 51 | 15.7N | 171.4W65  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081818                           | 52 | 16.2N | 173.6W65  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081900                           | 53 | 16.5N | 175.3W65  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081906                           | 54 | 16.6N | 176.4W65  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081912                           | 55 | 17.2N | 177.7W65  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99081918                           | 56 | 17.3N | 178.9W65  | 0  |    |    |    |     |     |   |   |    |    |    | 0  |
| 99082000                           | 57 | 17.9N | 179.5E 60 | 18 |    |    |    |     |     |   |   |    |    |    | 0  |
| 99082006                           | 58 | 18.4N | 178.2E 50 | 8  | 68 | 91 | 99 | 115 | 279 | 0 | 0 | 5  | 10 | 15 | 20 |
| 99082012                           | 59 | 19.1N | 177.6E 45 | 0  | 50 | 29 | 94 | 92  | 186 | 0 | 0 | 5  | 15 | 20 | 20 |
| 99082018                           | 60 | 19.7N | 176.7E 45 | 0  | 6  | 62 | 50 | 69  | 193 | 0 | 5 | 10 | 15 | 20 | 20 |
| 99082100                           | 61 | 20.6N | 175.4E 45 | 0  | 29 | 76 | 60 | 74  | 93  | 0 | 5 | 15 | 20 | 15 | 25 |

| Statistics for JTWC on HUR07E Dora |    |       |        |    |    |     |     |     |     |     |    |    |    |    |    |    |
|------------------------------------|----|-------|--------|----|----|-----|-----|-----|-----|-----|----|----|----|----|----|----|
| 99082106                           | 62 | 20.9N | 174.6E | 40 | 0  | 73  | 114 | 130 | 144 |     | 0  | 5  | 10 | 15 | 15 |    |
| 99082112                           | 63 | 21.3N | 173.4E | 40 | 0  | 33  | 8   | 30  | 40  |     | 0  | 10 | 15 | 15 | 10 |    |
| 99082118                           | 64 | 21.8N | 171.8E | 35 | 0  | 53  | 56  | 126 | 218 |     | 0  | 5  | 5  | 5  | 5  |    |
| 99082200                           | 65 | 22.4N | 170.7E | 30 | 0  | 57  | 76  | 149 |     |     | 0  | 0  | 0  | -5 |    |    |
| 99082206                           | 66 | 23.7N | 170.0E | 30 | 0  | 48  | 76  | 185 |     |     | 0  | 0  | 0  | 0  |    |    |
| 99082212                           | 67 | 24.2N | 169.3E | 25 | 32 | 84  | 116 | 294 |     |     | 0  | 0  | -5 | 0  |    |    |
| 99082218                           | 68 | 24.7N | 168.3E | 25 | 49 | 124 | 271 |     |     |     | 0  | 0  | 0  |    |    |    |
| 99082300                           | 69 | 25.3N | 167.7E | 25 | 0  | 64  | 204 |     |     |     | 0  | 0  | 5  |    |    |    |
| 99082306                           | 70 | 26.6N | 167.4E | 25 | 5  | 81  |     |     |     |     | 0  | 0  |    |    |    |    |
| 99082312                           |    | 27.5N | 167.1E | 25 |    |     |     |     |     |     |    |    |    |    |    |    |
| 99082318                           |    | 27.7N | 167.7E | 20 |    |     |     |     |     |     |    |    |    |    |    |    |
| 99082400                           |    | 28.0N | 168.3E | 15 |    |     |     |     |     |     |    |    |    |    |    |    |
| AVERAGE                            |    |       |        |    | 5  | 59  | 98  | 122 | 108 | 188 | 1  | 2  | 6  | 10 | 14 | 21 |
| BIAS                               |    |       |        |    |    |     |     |     |     |     | 1  | 2  | 5  | 9  | 14 | 21 |
| # CASES                            |    |       |        |    | 70 | 13  | 12  | 10  | 7   | 4   | 70 | 13 | 12 | 10 | 7  | 4  |

| Statistics for JTWC on TC 01B |     |                |       |                 |    |    |     |     |     |    |             |    |    |    |    |    |
|-------------------------------|-----|----------------|-------|-----------------|----|----|-----|-----|-----|----|-------------|----|----|----|----|----|
|                               |     | WRN BEST TRACK |       | POSITION ERRORS |    |    |     |     |     |    | WIND ERRORS |    |    |    |    |    |
| DTG                           | NO. | LAT            | LONG  | wind            | 00 | 12 | 24  | 36  | 48  | 72 | 00          | 12 | 24 | 36 | 48 | 72 |
| 99013012                      |     | 7.7N           | 92.0E | 20              |    |    |     |     |     |    |             |    |    |    |    |    |
| 99013018                      |     | 8.0N           | 91.8E | 25              |    |    |     |     |     |    |             |    |    |    |    |    |
| 99013100                      |     | 8.3N           | 91.2E | 25              |    |    |     |     |     |    |             |    |    |    |    |    |
| 99013106                      |     | 8.4N           | 90.6E | 25              |    |    |     |     |     |    |             |    |    |    |    |    |
| 99013112                      |     | 8.4N           | 90.0E | 25              |    |    |     |     |     |    |             |    |    |    |    |    |
| 99013118                      |     | 8.3N           | 89.2E | 25              |    |    |     |     |     |    |             |    |    |    |    |    |
| 99020100                      |     | 8.1N           | 88.5E | 25              |    |    |     |     |     |    |             |    |    |    |    |    |
| 99020106                      |     | 8.1N           | 87.7E | 25              |    |    |     |     |     |    |             |    |    |    |    |    |
| 99020112                      |     | 8.2N           | 87.0E | 25              |    |    |     |     |     |    |             |    |    |    |    |    |
| 99020118                      |     | 8.6N           | 86.4E | 25              |    |    |     |     |     |    |             |    |    |    |    |    |
| 99020200                      |     | 9.1N           | 85.7E | 25              |    |    |     |     |     |    |             |    |    |    |    |    |
| 99020206                      | 1   | 9.6N           | 85.2E | 35              | 16 | 56 | 100 | 135 | 163 |    | 0           | 10 | 10 | 20 | 20 |    |
| 99020218                      | 2   | 10.4N          | 84.7E | 35              | 18 | 48 | 104 | 152 | 198 |    | 0           | 0  | 10 | 10 | 15 |    |
| 99020306                      | 3   | 10.8N          | 84.5E | 40              | 11 | 35 | 59  | 77  |     |    | 0           | 5  | 5  | 10 |    |    |
| 99020318                      | 4   | 11.1N          | 84.3E | 35              | 21 | 43 | 58  |     |     |    | 0           | 0  | 0  |    |    |    |
| 99020406                      | 5   | 11.5N          | 84.1E | 35              | 6  | 0  |     |     |     |    | 0           |    |    |    |    |    |
| 99020418                      | 6   | 12.0N          | 84.0E | 30              | 0  |    |     |     |     |    | 0           |    |    |    |    |    |
| AVERAGE                       |     |                |       |                 | 12 | 36 | 80  | 121 | 181 |    | 0           | 3  | 6  | 13 | 18 |    |
| BIAS                          |     |                |       |                 |    |    |     |     |     |    | 0           | 3  | 6  | 13 | 18 |    |
| # CASES                       |     |                |       |                 | 6  | 5  | 4   | 3   | 2   |    | 6           | 5  | 4  | 3  | 2  |    |



| Statistics for JTWC on TC 02A |                |       |                 |      |    |     |     |     |     |     |             |     |     |     |     |     |
|-------------------------------|----------------|-------|-----------------|------|----|-----|-----|-----|-----|-----|-------------|-----|-----|-----|-----|-----|
| DTG                           | WRN BEST TRACK |       | POSITION ERRORS |      |    |     |     |     |     |     | WIND ERRORS |     |     |     |     |     |
|                               | NO.            | LAT   | LONG            | wind | 00 | 12  | 24  | 36  | 48  | 72  | 00          | 12  | 24  | 36  | 48  | 72  |
| 99051500                      |                | 12.0N | 72.5E           | 25   |    |     |     |     |     |     |             |     |     |     |     |     |
| 99051506                      |                | 12.1N | 72.5E           | 25   |    |     |     |     |     |     |             |     |     |     |     |     |
| 99051512                      |                | 12.2N | 72.5E           | 25   |    |     |     |     |     |     |             |     |     |     |     |     |
| 99051518                      |                | 12.3N | 72.5E           | 25   |    |     |     |     |     |     |             |     |     |     |     |     |
| 99051600                      |                | 12.4N | 72.4E           | 30   |    |     |     |     |     |     |             |     |     |     |     |     |
| 99051606                      | 1              | 12.6N | 72.2E           | 30   | 42 | 126 | 218 | 280 | 365 | 497 | 0           | 0   | -25 | -45 | -45 | -55 |
| 99051612                      | 2              | 13.1N | 71.7E           | 35   | 25 | 100 | 163 | 232 | 322 | 443 | 0           | -5  | -25 | -40 | -45 | -50 |
| 99051618                      | 3              | 13.8N | 71.0E           | 35   | 6  | 31  | 67  | 146 | 225 | 419 | 0           | -20 | -35 | -35 | -40 | -45 |
| 99051700                      | 4              | 14.5N | 70.3E           | 45   | 16 | 38  | 67  | 138 | 213 |     | 0           | -15 | -25 | -30 | -40 |     |
| 99051706                      | 5              | 15.2N | 69.7E           | 65   | 0  | 23  | 75  | 149 | 239 | 453 | 0           | -15 | -15 | -20 | -20 | -15 |
| 99051712                      | 6              | 15.7N | 69.1E           | 70   | 0  | 33  | 92  | 173 | 263 | 448 | 0           | -15 | -20 | -25 | -20 | -5  |
| 99051718                      | 7              | 16.3N | 68.6E           | 90   | 0  | 42  | 87  | 153 | 253 | 427 | 0           | 5   | 5   | 5   | -10 | -15 |
| 99051800                      | 8              | 17.1N | 68.1E           | 90   | 6  | 54  | 100 | 156 | 227 | 350 | 0           | 0   | 0   | 0   | -15 | -15 |
| 99051806                      | 9              | 18.0N | 67.7E           | 95   | 0  | 29  | 66  | 123 | 173 | 259 | 0           | -5  | -5  | -5  | -15 | 10  |
| 99051812                      | 10             | 18.9N | 67.3E           | 100  | 5  | 47  | 86  | 143 | 177 | 293 | 0           | -10 | -5  | -10 | -5  | 20  |
| 99051818                      | 11             | 19.6N | 67.2E           | 105  | 8  | 33  | 82  | 108 | 115 | 152 | 0           | 0   | 0   | 5   | 15  | 20  |
| 99051900                      | 12             | 20.4N | 67.1E           | 110  | 6  | 28  | 77  | 101 | 131 |     | 0           | 0   | 5   | 10  | 15  |     |
| 99051906                      | 13             | 21.1N | 67.1E           | 110  | 11 | 50  | 93  | 118 | 143 |     | 0           | 0   | 0   | 10  | -10 |     |
| 99051912                      | 14             | 21.8N | 67.3E           | 110  | 5  | 13  | 24  | 48  |     |     | 0           | 0   | -30 | -50 |     |     |
| 99051918                      | 15             | 22.5N | 67.6E           | 110  | 8  | 21  | 73  | 149 |     |     | -5          | -20 | -50 | -35 |     |     |
| 99052000                      | 16             | 23.1N | 67.9E           | 110  | 8  | 21  | 63  | 133 |     |     | 0           | 0   | -35 | -25 |     |     |
| 99052006                      | 17             | 23.6N | 68.2E           | 110  | 0  | 8   | 29  | 38  |     |     | -5          | -30 | -20 | -25 |     |     |
| 99052012                      | 18             | 24.0N | 68.3E           | 100  | 0  | 33  | 77  |     |     |     | 0           | -20 | -10 |     |     |     |
| 99052018                      | 19             | 24.4N | 68.7E           | 100  | 11 | 37  | 60  |     |     |     | 0           | 20  | -10 |     |     |     |
| 99052100                      | 20             | 24.7N | 69.1E           | 90   | 0  | 24  |     |     |     |     | 0           | 10  |     |     |     |     |
| 99052106                      | 21             | 25.0N | 69.6E           | 65   | 0  | 39  |     |     |     |     | 0           | -10 |     |     |     |     |
| 99052112                      |                | 25.6N | 70.2E           | 55   |    |     |     |     |     |     |             |     |     |     |     |     |
| 99052118                      |                | 26.0N | 70.7E           | 55   |    |     |     |     |     |     |             |     |     |     |     |     |
| AVERAGE                       |                |       |                 |      | 8  | 40  | 84  | 141 | 219 | 374 | 0           | 10  | 17  | 22  | 23  | 25  |
| BIAS                          |                |       |                 |      |    |     |     |     |     |     | 0           | -6  | -16 | -19 | -18 | -15 |
| # CASES                       |                |       |                 |      | 21 | 21  | 19  | 17  | 13  | 10  | 21          | 21  | 19  | 17  | 13  | 10  |

| Statistics for JTWC on TC 03B |                |       |                 |      |    |    |    |    |    |    |             |    |    |    |    |    |
|-------------------------------|----------------|-------|-----------------|------|----|----|----|----|----|----|-------------|----|----|----|----|----|
| DTG                           | WRN BEST TRACK |       | POSITION ERRORS |      |    |    |    |    |    |    | WIND ERRORS |    |    |    |    |    |
|                               | NO.            | LAT   | LONG            | wind | 00 | 12 | 24 | 36 | 48 | 72 | 00          | 12 | 24 | 36 | 48 | 72 |
| 99060806                      |                | 18.5N | 91.4E           | 20   |    |    |    |    |    |    |             |    |    |    |    |    |
| 99060812                      |                | 18.5N | 91.2E           | 25   |    |    |    |    |    |    |             |    |    |    |    |    |
| 99060818                      |                | 18.5N | 91.0E           | 25   |    |    |    |    |    |    |             |    |    |    |    |    |
| 99060900                      |                | 18.6N | 90.9E           | 25   |    |    |    |    |    |    |             |    |    |    |    |    |
| 99060906                      |                | 18.9N | 90.7E           | 25   |    |    |    |    |    |    |             |    |    |    |    |    |
| 99060912                      |                | 19.3N | 90.5E           | 25   |    |    |    |    |    |    |             |    |    |    |    |    |
| 99060918                      |                | 19.9N | 90.3E           | 25   |    |    |    |    |    |    |             |    |    |    |    |    |

| Statistics for JTWC on TC 03B |   |         |       |    |    |     |    |  |   |    |   |
|-------------------------------|---|---------|-------|----|----|-----|----|--|---|----|---|
| 99061000                      |   | 20.3N   | 90.0E | 25 |    |     |    |  |   |    |   |
| 99061006                      |   | 20.7N   | 89.5E | 25 |    |     |    |  |   |    |   |
| 99061012                      | 1 | 21.1N   | 88.4E | 35 | 12 | 99  | 98 |  | 0 | 20 | 5 |
| 99061100                      | 2 | 22.9N   | 85.8E | 25 | 0  | 108 |    |  | 0 | 0  |   |
| 99061106                      |   | 23.5N   | 85.3E | 20 |    |     |    |  |   |    |   |
| 99061112                      |   | 24.2N   | 84.8E | 20 |    |     |    |  |   |    |   |
| 99061118                      |   | 25.0N   | 84.4E | 20 |    |     |    |  |   |    |   |
|                               |   | AVERAGE |       |    | 6  | 103 | 98 |  | 0 | 10 | 5 |
|                               |   | BIAS    |       |    |    |     |    |  | 0 | 10 | 5 |
|                               |   | #       |       |    | 2  | 2   | 1  |  | 2 | 2  | 1 |
|                               |   | CASES   |       |    |    |     |    |  |   |    |   |

| Statistics for JTWC on TC 04B |     |                |       |                 |    |    |     |     |    |    |             |     |     |     |     |    |
|-------------------------------|-----|----------------|-------|-----------------|----|----|-----|-----|----|----|-------------|-----|-----|-----|-----|----|
|                               |     | WRN BEST TRACK |       | POSITION ERRORS |    |    |     |     |    |    | WIND ERRORS |     |     |     |     |    |
| DTG                           | NO. | LAT            | LONG  | wind            | 00 | 12 | 24  | 36  | 48 | 72 | 00          | 12  | 24  | 36  | 48  | 72 |
| 99101500                      |     | 14.5N          | 92.7E | 20              |    |    |     |     |    |    |             |     |     |     |     |    |
| 99101506                      |     | 15.2N          | 91.4E | 25              |    |    |     |     |    |    |             |     |     |     |     |    |
| 99101512                      |     | 15.4N          | 90.2E | 30              |    |    |     |     |    |    |             |     |     |     |     |    |
| 99101518                      | 1   | 15.8N          | 89.3E | 45              | 0  | 13 | 26  | 45  | 54 |    | -10         | -10 | -25 | -70 | -50 |    |
| 99101606                      | 2   | 16.6N          | 87.4E | 55              | 0  | 17 | 55  | 80  |    |    | 0           | -15 | -50 | -60 |     |    |
| 99101618                      | 3   | 17.5N          | 85.8E | 80              | 5  | 55 | 79  |     |    |    | -15         | -55 | -60 |     |     |    |
| 99101700                      | 4   | 17.7N          | 85.3E | 120             | 0  | 35 | 75  | 148 |    |    | -5          | -30 | -40 | -10 |     |    |
| 99101706                      | 5   | 18.0N          | 84.9E | 120             | 0  | 58 | 130 |     |    |    | 0           | 0   | -15 |     |     |    |
| 99101718                      | 6   | 19.2N          | 84.7E | 90              | 0  | 38 |     |     |    |    | 10          | -10 |     |     |     |    |
| 99101806                      | 7   | 21.1N          | 84.5E | 65              | 5  |    |     |     |    |    | 0           |     |     |     |     |    |
| 99101812                      |     | 22.4N          | 84.7E | 40              |    |    |     |     |    |    |             |     |     |     |     |    |
|                               |     | AVERAGE        |       |                 | 2  | 36 | 73  | 91  | 54 |    | 6           | 20  | 38  | 47  | 50  |    |
|                               |     | BIAS           |       |                 |    |    |     |     |    |    | -3          | -20 | -38 | -47 | -50 |    |
|                               |     | #              |       |                 | 7  | 6  | 5   | 3   | 1  |    | 7           | 6   | 5   | 3   | 1   |    |
|                               |     | CASES          |       |                 |    |    |     |     |    |    |             |     |     |     |     |    |

| Statistics for JTWC on TC 05B |     |                |       |                 |    |    |     |     |     |    |             |     |     |     |     |    |
|-------------------------------|-----|----------------|-------|-----------------|----|----|-----|-----|-----|----|-------------|-----|-----|-----|-----|----|
|                               |     | WRN BEST TRACK |       | POSITION ERRORS |    |    |     |     |     |    | WIND ERRORS |     |     |     |     |    |
| DTG                           | NO. | LAT            | LONG  | wind            | 00 | 12 | 24  | 36  | 48  | 72 | 00          | 12  | 24  | 36  | 48  | 72 |
| 99102500                      |     | 11.5N          | 99.2E | 25              |    |    |     |     |     |    |             |     |     |     |     |    |
| 99102506                      |     | 12.0N          | 97.9E | 25              |    |    |     |     |     |    |             |     |     |     |     |    |
| 99102512                      |     | 12.7N          | 96.9E | 25              |    |    |     |     |     |    |             |     |     |     |     |    |
| 99102518                      |     | 13.2N          | 96.3E | 25              |    |    |     |     |     |    |             |     |     |     |     |    |
| 99102600                      | 1   | 13.8N          | 95.5E | 35              | 0  | 0  | 0   | 18  | 13  |    | 0           | 0   | -10 | -25 | -25 |    |
| 99102612                      | 2   | 15.0N          | 93.9E | 45              | 0  | 12 | 32  | 32  | 48  |    | 0           | -10 | -25 | -25 | -45 |    |
| 99102700                      | 3   | 16.0N          | 92.3E | 65              | 26 | 62 | 40  | 0   | 64  |    | -5          | -20 | -20 | -45 | -45 |    |
| 99102712                      | 4   | 16.7N          | 90.9E | 90              | 0  | 41 | 59  | 41  | 69  |    | 0           | 0   | -25 | -25 | 0   |    |
| 99102800                      | 5   | 17.6N          | 89.1E | 100             | 0  | 6  | 33  | 113 | 246 |    | 0           | -30 | -40 | -20 | -5  |    |
| 99102812                      | 6   | 18.6N          | 87.7E | 135             | 0  | 6  | 61  | 198 |     |    | 0           | 0   | -15 | -20 |     |    |
| 99102900                      | 7   | 19.6N          | 86.7E | 140             | 8  | 34 | 109 | 222 | 340 |    | 0           | 0   | 5   | 15  | 5   |    |

| Statistics for JTWC on TC 05B |    |         |       |     |    |    |     |     |    |     |     |     |     |
|-------------------------------|----|---------|-------|-----|----|----|-----|-----|----|-----|-----|-----|-----|
| 99102912                      | 8  | 20.4N   | 86.0E | 115 | 18 | 72 | 212 |     | 0  | -10 | -10 |     |     |
| 99103000                      | 9  | 20.6N   | 85.9E | 80  | 16 | 70 | 167 |     | 0  | 0   | -15 |     |     |
| 99103012                      | 10 | 20.3N   | 85.8E | 45  | 0  | 13 | 48  |     | 0  | -5  | -10 |     |     |
| 99103100                      | 11 | 19.9N   | 85.9E | 40  | 6  | 24 | 29  | 91  | 0  | 10  | 15  | 5   |     |
| 99103112                      | 12 | 19.2N   | 85.8E | 35  | 20 | 12 | 72  |     | 0  | 0   | 0   |     |     |
| 99110100                      | 13 | 18.9N   | 85.5E | 30  | 8  | 45 |     |     | 0  | 0   |     |     |     |
| 99110106                      |    | 18.6N   | 85.3E | 25  |    |    |     |     |    |     |     |     |     |
| 99110112                      |    | 17.9N   | 85.1E | 25  |    |    |     |     |    |     |     |     |     |
| 99110118                      |    | 17.0N   | 84.9E | 25  |    |    |     |     |    |     |     |     |     |
| 99110200                      |    | 16.1N   | 84.8E | 25  |    |    |     |     |    |     |     |     |     |
| 99110206                      |    | 15.9N   | 84.7E | 20  |    |    |     |     |    |     |     |     |     |
| 99110212                      |    | 15.8N   | 84.5E | 15  |    |    |     |     |    |     |     |     |     |
| 99110218                      |    | 15.7N   | 84.1E | 15  |    |    |     |     |    |     |     |     |     |
| 99110300                      |    | 15.8N   | 83.7E | 15  |    |    |     |     |    |     |     |     |     |
| 99110306                      |    | 16.0N   | 83.3E | 15  |    |    |     |     |    |     |     |     |     |
|                               |    | AVERAGE |       | 8   | 31 | 72 | 89  | 130 | 0  | 7   | 16  | 23  | 21  |
|                               |    | BIAS    |       |     |    |    |     |     | 0  | -5  | -13 | -18 | -19 |
|                               |    | #       |       | 13  | 13 | 12 | 8   | 6   | 13 | 13  | 12  | 8   | 6   |
|                               |    | CASES   |       |     |    |    |     |     |    |     |     |     |     |

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